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IN ALL ITS APPLICATIONS TO

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ON THE HEAT DEVELOPED IN THE COMBINATION OF ACIDS AND BASES.*

By THOMAS ANDREWS, M.D., F.R.S., Hon.F.R.S.E.,
Vice-President of Queen's College, Belfast.

In a paper communicated to the Royal Irish Academy in 1841, I gave an account of a large number of experiments on the heat disengaged when acids and bases, taken in the state of dilute solution, enter into combination, and when bases, insoluble in water, are dissolved in dilute acids. The following general conclusions or laws were deduced from those experiments:—

Law 1.—The heat developed in the union of acids and bases is determined by the base and not by the acid, the same base producing, when combined with an equivalent of different acids, nearly the same quantity of heat; but different bases, different quantities.

Law 2.—When a neutral is converted into an acid salt, by combining with one or more atoms of acid, no change of temperature occurs.

Law 3.—When a neutral is converted into a basic salt, by combining with an additional proportion of base, the combination is accompanied with the evolution of heat.†

Three years later, I laid before the Royal Society of London the results of an experimental investigation of the heat developed when one base is substituted for another in chemical compounds. The law deduced from this inquiry is implicitly involved in the foregoing, of which it may indeed be regarded as a necessary consequence. It was enunciated in the following terms:—

Law 4.—When one base displaces another from any of its neutral combinations, the heat evolved or abstracted is always the same, whatever the acid element may be provided the bases are the same.‡

Finally, the law of metallic substitutions, first announced in the *Philosophical Magazine* for August 1844, was then stated in a paper published in the *Philosophical Transactions* for 1848.

Law 5.—When an equivalent of one and the same metal replaces another in a solution of any of its salts of the same order, the heat developed is always the same; but a change in either of the metals produces a different development of heat.

In 1845, a paper appeared by Graham on the heat disengaged in combinations, the second part of which refers to the heat produced when hydrate of potash is neutralised by different acids.‖ The results arrived at by this distinguished chemist exhibit a close agreement with those contained in my first communication to the Royal Irish Academy.

The concluding part of the elaborate memoir of MM. Favre and Silbermann on the heat disengaged in chemical actions is chiefly devoted to the same subject. A large number of experiments are described, which are nearly a repetition of those I had previously published. Their results bear a general resemblance to those given by myself in 1841; but they widely differ in the details. The authors of this able memoir fully recognise the accuracy of my fourth law, which asserts the equality of thermal effect when one base is substituted for another. "M. Andrews," they observe, "avait en effet établi que, quelque soit l'acide d'un sel la quantité de chaleur dégagée par la substitution d'une base à une autre pour former un nouveau sel est la même, lorsque l'on considère les deux mêmes bases."*

In a preceding paragraph of the same memoir, the authors object to what they conceive to be my first law, and state that it is not in accordance, with the results of their investigations. As the question is one of some importance, I may, perhaps, be permitted to quote the passage in the original language. "Ses conclusions, savoir: que la chaleur dégagée par l'équivalent d'une même base combinée aux divers acides est la même, ne s'accordent pas avec les résultats de nos recherches, et ne nous paraissent pas pouvoir être admises." No doubt, through inadvertence, MM. Favre and Silbermann have here given an inaccurate statement of my first law. It did not declare that precisely the same amount of heat is disengaged by all the acids in combining with the same base, but that the heat is determined by the base, "the same base producing, when combined with an equivalent of different acids, *nearly* the same quantity of heat." A comparison of the results of MM. Favre and Silbermann with those in my original memoir will show that I had fully recognised and described the deviations from the other acids, exhibited, on the one hand, in excess, by the sulphuric acid, and, on the other, in deficiency, by the tartaric, citric, and succinic acids. "If we refer," I remarked, in the original memoir of 1841, "to the first, second, and fourth tables, as being the most extensive, from the large number of soluble compounds formed by potash, soda, and ammonia, it will be observed that the sulphuric acid developes from 0·8° to nearly 1° more than the mean heat given by the other acids; while the tartaric, citric, and succinic acids fall from 0·4° to 0·55° short of the same. A minute investigation of the influence of the disturbing sources of heat will, no doubt, discover the causes of these discrepancies. The high numbers for sulphuric acid are probably connected with that acid's well-known property of developing much heat when combining with successive atoms of water. All the other acids develope nearly the same amount of heat in combining with the same base, the greatest divergences from the mean quantity being, in the case of potash, + 0·24° and − 0·13°; in that of soda, + 0·26° and − 0·14°; and in that of ammonia, + 0·17° and − 0·05°. These differences are almost within the limits of the errors of experiment."†

* Communicated by the Author. Abstract of a paper read before the Royal Society of Edinburgh.

† *Transactions of the Royal Irish Academy*, vol. xix., p. 228.

‡ *Philosophical Transactions* for 1844, p. 21.

‖ *Memoirs of the Chemical Society*, vol. ii., p. 51.

* *Annales der Chimie et de Physique*, 3ème ser., xxxvii., p. 497 (1853).

† *Transactions of the Royal Irish Academy*, vol. xix., p. 240.

But although there is a superficial agreement between my original results and those of MM. Favre and Silbermann, they will be found, when examined closely, to differ widely in detail, and on points of great importance. I had found that the oxalic acid disengages almost exactly the same amount of heat in combining with the soluble bases as the hydrochloric, nitric, and many other mineral acids, and this observation I have always regarded as one of the main foundations of Law 1. MM. Favre and Silbermann, on the contrary, have inferred from their experiments that "the following organic acids —the oxalic, formic, valeric, and citric—disengage sensibly the same quantity of heat, but it is less (plus faible) than that given by the foregoing mineral acids" —among which they enumerate the nitric and hydrochloric. According to my experiments, no distinction of this kind can be admitted between acids derived from the mineral and organic kingdom, inasmuch as the oxalic acid developes at least as much heat in combining with the bases as the hydrochloric, nitric, and several other strong mineral acids.

The experiments to be described in this paper were made some years ago, but their publication has been deferred from accidental circumstances. I have, however, recently repeated a few of the more important of them, with a slightly modified form of apparatus. The solutions were taken in so dilute a state that the heat disengaged never exceeded 3·5° C. A standard solution of sulphuric acid was prepared and carefully analysed, by precipitating a given weight with a soluble salt of barium, and weighing the sulphate of barium. The strength of the alkaline solutions was adjusted with great care by means of this standard acid. The same solution of each alkali was employed in all the experiments, and the quantity used in each experiment was determined by careful weighing. The acid solution was of such a strength that, after being mixed with the alkali, an excess of two or three per cent of acid was present. The alkaline solution was contained in a light glass vessel, in which a large platinum crucible holding the acid was carefully floated. By giving a rapid rotation, by means of a light stirrer, to the acid solution in the platinum crucible, a perfect equilibrium of temperature was soon established between the two liquids. The initial temperature of the solutions was usually about 1·5° below that of the air, and the final temperature of the mixture about 1·5° above it. The corrections for the heating and cooling action of the surrounding medium were determined with great care. The mechanical process of adding the acid to the alkaline solution produced no change of temperature, and as the heat disengaged in the combination raised the liquid almost instantly to the maximum temperature, the whole correction required was for cooling. The first temperature was read one minute after the addition of the acid to the alkaline solution, the mixture being stirred during the whole of that time. If δ represents the correction, and ϵ the excess of temperature above the air in centigrade degrees, the value of δ will be given by the following expression:—

$$\delta = \epsilon \times 0{\cdot}012^{\circ}.$$

As a proof of the accuracy of the method of mixture adopted in this inquiry, I may mention that, being desirous to know whether the dilute acids employed in these experiments produced any change of temperature when mixed with water, I made the experiment with nitric acid by the method just described, substituting water for the alkaline solution, with the unexpected result of a fall of 0·01°. On varying the conditions of the observation, so as to obtain a larger effect, it was ascertained not only that a diminution of temperature had actually occurred, but that the observed fall represented approximately its true amount. When hydrochloric acid of equivalent strength was diluted to the same extent, an elevation of temperature of 0·05° was produced.

The accuracy of experiments of this kind, where the whole thermal effect observed amounts only to 2° or 3°, depends greatly on the thermometer employed. Unless its indications are perfectly trustworthy in every part of the scale, the labour of the inquirer will only end in disappointment. I have, therefore, taken every precaution to secure this important object. The tube of the thermometer was calibrated and divided with care, according to an arbitrary scale, by means of a dividing iustrument contrived for the purpose, and provided with a short screw of great accuracy made by Troughton and Simms. The divisions, etched finely on the glass, corresponded to about 0·05° C., and the readings could be made with certainty to less than 0·01°. The division of the scale, corresponding to 0°, was determined from time to time in the usual way; and another point, about 30° C., was fixed by comparison with four other thermometers similarly constructed, whose scales extended from the freezing to the boiling point of water. The readings of these four instruments, when reduced to degrees, rarely differed from each other within the limits to which they could be read, or 0·02°. The reservoir of the thermometer used in these experiments was 75 millimetres long, and, when immersed in the liquid, occupied nearly its entire depth.

As some uncertainty always exists with regard to the thermal equivalent of glass vessels, I made two sets of comparative experiments—one with a thickly varnished copper vessel, and the other with a vessel of platinum. The mean result of these experiments coincided almost exactly with the result obtained when the glass vessel was employed.

The weight of the glass vessel which contained the alkaline solution was 58 grammes, and corresponded thermally to 11·4 grms of the solutions formed. The thermal equivalent of the reservoir of the thermometer and of the stirrer was 0·9 grms. The alkaline solution weighed 160 grms, and contained the equivalent of 1·738 grms of SO_3. The acid solution weighed 42·5 grms. Hence the entire thermal value of the apparatus, in terms of the solution formed, was—

Solution	202·5
Glass vessel	11·4
Thermometer and stirrer	0·9
	214·8 grms.

A correction (additive) of 1-240th was made to the direct readings for the mercury in the stem of thermometer.

In the following table I have collected the results of my experiments, arranging the acids in the order of their thermal action:—

Acid.	Potash. Deg.	Soda. Deg.	Ammonia. Deg.
Sulphuric acid	3·378	3·353	2·976
Oxalic acid	3·058	3·040	2·648
Hydrochloric acid ..	3·021	3·982	2·623
Nitric acid	2·993	2·929	2·566
Acetic acid	2·852	2·832	2·492
Tartaric acid	2·732	2·710	2·376

It is interesting to observe how closely the results in the three vertical columns agree relatively with one another. The acids follow in the same order under each base, and even the differences in the amount of heat disengaged by the several acids in combining with the different bases approximate in many cases closely to one another. Thus the heat given out when the sulphuric acid combines with potash exceeds that given out when the oxalic acid combines with the same base by 0·320°, the corresponding differences in the case of soda and ammonia being 0·313° and 0·328°. If, in like manner, we compare the differences between the heat disengaged by the acetic and tartaric acids, we fall upon the numbers 0·012°, 0·122°, and 0·116°. Even in the case of the oxalic, hydrochloric, and nitric acids, which disengage so nearly the same amount of heat, the same order is observed with the three bases. It must be particularly remarked that the oxalic acid disengages from 0·022° to

0·058° more heat in combining with these bases than the hydrochloric acid, and from 0·065° to 0·111° more than the nitric acid. The conclusion of MM. Favre and Silbermann, that the organic acids (oxalic, formic, acetic, &c.) disengage sensibly less heat than the mineral acids, is thus entirely disproved; and the original results recorded in my work of 1841, according to which the oxalic acid disengages at least as much heat as the nitric, phosphoric, arsenic, hydrochloric, hydriodic, boracic, and other mineral acids (with the exception of the sulphuric acid) are fully confirmed. The tartaric, citric, and succinic acids, it is true (as was also shown in the same work), give out about $\frac{1}{15}$th less heat than the average of the other acids; but the acetic and formic acids fall scarcely $\frac{1}{30}$th below the mean, and the oxalic acid is always above it. These results, in all their main features, are fully corroborated by the experiments which were performed with a more perfect apparatus and a more exact thermometer than I had at my command in my earlier investigations. A reference to the same paper will show that, while acids, differing so widely from one another as the oxalic, phosphoric, arsenic, nitric, hydrochloric, and boracic acids, scarcely present any sensible difference in the quantities of heat which they disengage in combining with the bases; and while of the other acids examined the sulphuric acid (and probably also the sulphurous acid) presents an extreme deviation of about $\frac{1}{7}$th above the mean, and the tartaric acid group a deviation of about $\frac{1}{30}$th below it, the bases, on the contrary (and the subsequent researches of Favre and Silbermann have confirmed this result), differ altogether in thermal power from one another. Thus, equivalents of the oxides of magnesium and of silver give out 4·1° and 1·8° of heat respectively in combining with nitric acid, the former oxide having therefore 2·3 times the thermal power of the latter. Yet, as is well known, both these bases fully saturate the acid, and the resulting solutions are even neutral to test-paper. For these reasons, I have no doubt whatever that the first law, as enunciated in 1841, is the expression of a true physical law, and that in the combination of acids and bases in presence of water the heat disengaged is determined by the base and not by the acid. It is true that in this, as in similar physical inquiries, experimental results cannot immediately be obtained free from complication or disturbing influences. The same remark applies to the experimental proof of the great law discovered by Dulong and Petit, which connects the specific heats and atomic weights of the elementary bodies, and also to that of the remarkable relations discovered by Kopp between the composition and boiling points of many organic liquids. We have already seen an illustration of one of these disturbing influences, in the fact that dilute nitric acid, when mixed with water, gives a slight fall of temperature; hydrochloric acid, a rise; and the differences of specific heat in the solutions formed will to a small extent modify the results. But the cause of the higher thermal power of sulphuric acid I have not been able to discover, and future researches must decide whether it depends upon some disturbing cause, or, which is less probable, upon its possessing an exceptionally high thermal power. One condition is, however, essential, or Law 1 will not apply. The acid and base must be capable of combining when brought into contact, and of forming a stable compound. In the paper so often referred to, I showed that hydrocyanic acid and potash, which fail to fulfil this condition, do not disengage the normal amount of heat when mixed; and the same observation will doubtless be found to apply to a large number of metallic oxides, which form unstable compounds with, and imperfectly neutralise the bases.

As regards the experimental proofs of the other laws, even those of the fourth law, the truth of which is admitted by MM. Favre and Silbermann, they are only approximative; and here also we meet occasionally with peculiar and unexpected results. Thus a slight fall of temperature occurs, as Hess showed long ago, in the conversion of the neutral sulphate of potash into the acid salt; and I found, as indeed might have been expected from their alkaline reaction, that in the conversion of the ordinary phosphates and arseniates into super salts, a disengagement of heat occurs, amounting to about one-seventh of that disengaged in the formation of the salts themselves. In other cases, results, at first view startling and apparently anomalous, will be found to be strictly in accordance with the general principles already laid down. In the formation of double salts there is no disengagement of heat—a principle announced in 1841, and which ought perhaps to be enunciated as a distinct law, although it is implicitly involved in Law 2. Again, if tribasic phosphoric acid or arsenic acid is added in fractional portions to a solution of potash till the subsalts are formed, the heat disengaged on each addition of acid corresponds to the amount of acid added; but after this point has been reached, the disengagement of heat follows a different law. The pyrophosphoric acid, on the other hand, behaves in the same way as the nitric and most other acids, when added in successive portions to solutions of potash or soda; equal increments of heat being evolved for equal additions of acid, till the pyrophosphate of potash or soda is formed.*

Appendix.

In the following tables I have given the results described in this communication and those of 1841 in a form which admits of comparison with one another, and with those of MM. Favre and Silbermann. I have also added a few determinations recently made by M. Thomsen of Copenhagen.† It will be seen that the original experiments of 1841 exhibit, on the whole, a fair agreement with those now communicated From the small scale on which they were performed (the whole weight of the solutions after mixture being less than 30 grammes), the imperfect form of the apparatus, and the uncertainty of the thermometric indications, I have indeed been surprised to find them so near the truth. The results of MM. Favre and Silbermann do not exhibit the precision which might have been expected from the high character of those experimentalists, and from the accuracy of other parts of their great work. The mercurial calorimeter employed by them appears to have been little adapted to its purpose; but after making due allowance for its imperfections, I am at a loss to account for the serious errors into which they have fallen. M. Thomsen's experiments have evidently been made with care, and his results agree comparatively with my own; but the absolute amount of heat obtained by him falls far short of what I have found. It is indeed much easier to obtain results relatively than absolutely correct. The numbers given in this paper will, I believe, be found rarely to differ *relatively* more than 1-200th from the truth, but they may hereafter require a small correction in respect to their *absolute* value. That correction can, however, be scarcely more than $\frac{1}{30}$th of the whole amount; and I have little doubt that the number, for example, given by Thomsen to express the heat disengaged in the combination of soda with nitric acid will prove to be as far below the true number as that given by MM. Favre and Silbermann is above it.

TABLE I.—*Potash.*

Acid.	Andrews, 1841.	Favre and Silbermann.	Andrews, 1870.
Sulphuric ..	16,330 ..	16,083 ..	16,701
Nitric	15,076 ..	15,510 ..	14,800
Hydrochloric .	14,634 ..	15,656 ..	14,940
Oxalic	14,771 ..	14,156 ..	15,124
Acetic	14,257 ..	13,973 ..	13,805
Tartaric.. ..	13,612 ..	13,425 ..	13,508

* *Transactions of the Royal Irish Academy*, vol. xix. pp. 245—248. The observations of Graham confirm the statement that no heat is evolved in the formation of any double salt. *Memoirs of the Chemical Society*, vol. i. p. 83.

† *Poggendorff's Annalen*, cxxxviii. p. 78.

TABLE II.—*Soda.*

Acid.	Andrews, 1841.	Favre and Silbermann.	Andrews, 1870.	Thomsen.
Sulphuric ..	16,483 ..	15,810 ..	16,580 ..	15,689
Nitric	14,288 ..	15,283 ..	14,480 ..	13,617
Hydrochloric	14,926 ..	15,128 ..	14,744 ..	13,740
Oxalic	14,796 ..	13,752 ..	15,032 ..	—
Acetic	14,946 ..	13,609 ..	14,000 ..	—
Tartaric ..	13,135 ..	13,651 ..	13,400 ..	—

TABLE III.—*Ammonia.*

Acid.	Andrews, 1841.	Favre and Silbermann.	Andrews, 1870.
Sulphuric ..	14,135 ..	14,690 ..	14,710
Nitric	12,440 ..	13,676 ..	12,683
Hydrochloric .	12,440 ..	13,536 ..	12,964
Oxalic	12,684 ..	— ..	13,088
Acetic	12,195 ..	12,649 ..	12,316
Tartaric	11,400 ..	— ..	11,744

ANALYSIS OF A NEW MINERAL FROM BURMAH.

By D. WALDIE.

During the period extending from November, 1863, to the end of 1864, I had various samples of metallic ores sent to me for analysis by Mr. O'Riley, the Deputy Commissioner of Martaban, Burmah. They were mostly samples of galena, but one of a different kind particularly attracted my attention as of rather unusual composition, so that I suggested to him that it might be desirable to publish it. To this proposal he assented, suggesting that it should be presented to the journal of the Asiatic Society. Circumstances at the time prevented me from carrying my proposal into effect, but recently I resumed the investigation which had been lying long incomplete.

The analysis of the sample first sent by him on the 24th of July having been unsatisfactory on one point, and the specimen having been exhausted, I wrote to Mr. O'Riley for another sample, in order to settle this point. In reply he said that he had only a small specimen left, but sent me another small piece from the same range of hills, bearing a strong resemblance to the first, which he thought might probably be the same. I have no information of the locality whence they were got. Mr. O'Riley's letters were all dated from Shoaygyeen, except one in February, 1864, from the Karen country. In a subsequent letter, he mentioned that the samples referred to were from the same range of hills as a sample of ore he was then sending me, which turned out to be a double sulphide of copper and iron. This is all the information I can give of their source, as some time afterwards Mr. O'Riley died.

The following is the result of my analysis of the first sample sent on July 24th.

Copper	17·000
Silver	0·096
Iron	36·470
Antimony	1·150
Arsenic	32·700
Sulphur	1·360
Deficiency and loss	10·624
Earthy matter	0·560
Total	100·000

The silver is equal to 31½ ounces, troy, per ton.

The unsatisfactory point which I wished to clear up was the deficiency of 10·624, which I supposed might be oxygen combined with the metals. But this did not appear a very probable solution of the difficulty, and it might rather be owing to errors in analysis. The determinations had all been carefully made according to the usual methods. The arsenic and antimony were separated from the other metals by hydrosulphate of soda, and the arsenic determined as arsenate of magnesia and ammonia, and there was no reason to doubt the correctness of the process. But I had some fear that arsenic might have been lost during the operations preparatory to its separation from the other metals, and an experiment made on the second sample by conducting the analysis in the same way gave support to this view, as by this plan only 31·5 per cent of arsenic was obtained, instead of the 37 per cent indicated below by another process. Probably arsenic had been volatilised as chloride.

The second sample sent by Mr. O'Riley, October 11th, was similar in appearance to the first, but differed somewhat in composition, as will be seen presently. No particular note had been taken of the physical properties of the first sample. The second one was in the form of a flattened piece about ⅛th of an inch (or 1·2 centimetres) thick, with a dull, blackish, earthy looking surface. When broken it presented an uneven fracture, of a laminated structure, somewhat cellular, of a steel grey colour with a purplish tint and metallic lustre. In general appearance it is like mispickel, but of a redder shade. Minute specks of brownish green matter could be seen here and there on the surface, particularly between the lamellæ, when these presented themselves to view edgewise. It gives no streak on paper, but a dark grey one on unglazed porcelain. Hardness, 5·5.

Specific gravity at 81° F. (27° C.).

In small pieces	7·343
In powder	7·428

The pieces were boiled in the bottle, but no doubt still retained air in some interior cells.

It is easily soluble in nitric and nitro-hydrochloric acids, with evolution of nitrous fumes. One portion was dissolved slowly by diluted nitric acid containing 3 per cent its volume of nitric acid of 1400, and the solution completed somewhat more rapidly by a solution containing 5 per cent its volume. Hydrochloric acid at atmospheric temperature dissolved it partially by standing some time (two or three days), to the extent of about 10 or 11 per cent, and by repeated boiling about 13 per cent more, but there appeared no definite limit to the action. Acetic acid dissolves a portion, evidently oxidised matter.

Ignited in a platinum crucible it caked together, lost its metallic lustre, and became of a brownish colour, but whitish at the edges where it adhered to the crucible and was removed with some difficulty, having slightly attacked the platinum. By this ignition it increased nearly 2 per cent in weight. Ignited in a small glass tube by the blowpipe till the glass softened, it did not appear to yield any arsenic.

In the analysis of this sample, the arsenic (with a little antimony) was separated from the other metals by fusing with nitrate of potash, and carbonate of soda (potassium nitrate and sodium carbonate), or by passing chlorine into the mineral mixed with solution of potash. As in this case, however, the action was very slow, the mineral was first oxidised by a little nitric acid, then mixed with solution of potash in excess and chlorine passed through it. This plan answered very well. The results of two analyses for the three principal constituents, agreeing very well, were as follows:—

Copper	13·28
Iron	43·88
Arsenic	37·03

A complete analysis was made by digesting a portion for about twelve hours with diluted hydrochloric acid, and thus removing the oxidised matters. The results were as follows:—

Soluble in dilute hydrochloric acid.

Oxide of copper	1·21
Protoxide of iron	1·97
Oxide of lead	1·89
Arsenious acid	1·12
	6·19

Insoluble.		
Copper	12·13	
Iron	42·12	
Arsenic	38·45	
Antimony	0·54	
Earthy matters	0·12	
		93·36
		99·55
Loss		0·45
		100·00

In one small piece I found 2·67 per cent of matters insoluble in nitro-muriatic acid, but generally it was very small.

It will be observed that this sample differs from the first in the smaller proportion of what may be considered accidental constituents, and is a purer specimen of the essential constituents, arsenic, iron, and copper. The inside pieces contained no sulphur; the outside crust yielded a trace probably in the state of earthy sulphate. And while the first sample contained a notable quantity of silver, this did not appear to contain any, or at least so little that I could not detect it in the amount of material at my disposal. The quantity of antimony was also less than half that of the first sample.

I have not been able to find in any book on mineralogy I have had access to a description of such a mineral. The nearest are arsenical iron pyrites (mispickel) and axotomous arsenical iron. But it differs from the former in the total absence of sulphur, and from both in the presence of a considerable quantity of copper, as well as in the larger proportion of iron, and it differs still more in the proportion of the two basic metals together to the arsenic, the latter being small in proportion to the former.

The constituents approximate, though not very closely, to two equivalents of arsenic, six of iron and one of copper; rather more than six of iron and less than one of copper. This can scarcely be reduced to any probable atomic formula; but if the proper metallic nature of arsenic be admitted it may be considered as an alloy, and alloys are not limited in their composition to definite formula. The excess of basic metals in its composition gives it a fixity under the action of heat not very usual in arsenides or unoxidised arsenical compounds.

I would venture to propose for this mineral the name of O'Rileyite, in honour of the gentleman who sent it to me, whose services have unfortunately been lost to the Indian Government by an untimely death. This notice may perhaps lead explorers of these districts to discover additional specimens of this or analogous minerals.

ON THE

EXAMINATION OF THE BESSEMER FLAME WITH COLOURED GLASSES AND WITH THE SPECTROSCOPE.*

By J. M SILLIMAN, M.E.,
Adj. Professor of Metallurgy, Lafayette College, Easton, Pa.

(Concluded from vol. xxii., p. 314).

II. Examination With the Spectroscope.

THE science of spectrum analysis is yet in its infancy, and there has been no scientific investigation, perhaps, which has been more contradictory in its results than that of the Bessemer flame. The first application of the spectroscope to the analysis of the Bessemer flame was made in 1862 by Dr. Roscoe at the works of Messrs. John Brown and Co., in Sheffield. Soon after this it was in constant use in Brown's works for controlling the process. It was next introduced at Crewe, and from there said to have been taken to Seraing, in Belgium, in 1865.

Roscoe's account of the general appearance of the spectrum has not altogether been verified by subsequent observers. His not having seen any line beyond 80° indicates an imperfection in his instrument. He, also, is the only one who claims to have seen the sodium line as an absorption-band, or who professes to have detected the lines of nitrogen and hydrogen in the Bessemer spectrum. His spectroscope was so arranged that the spectrum of the Bessemer flame was seen in the upper half of the field of view, while the spectrum with which it was to be compared was seen immediately below. The spectrum of the flame was thus compared with the following spectra:—

1. Spectrum of electric discharge in carbonic oxide vacuum.
2. Spectrum of strong spark between silver poles in air.
3. Spectrum of strong spark between iron poles in air.
4. Spectrum of strong spark between iron poles in hydrogen.
5. Solar spectrum.
6. Carbon spectrum—oxyhydrogen blowpipe supplied with olefiant gas and oxygen.

The coincidences observed were very few, and totally failed to explain the value of the Bessemer spectrum. The lines of the well-known carbon spectrum did not occur at all, either as bright lines or absorption-bands, nor was any coincidence observed between the lines of the Bessemer spectrum and those of the carbonic oxide vacuum tube. The lines of lithium, sodium, and potassium were strongly marked and identified with certainty. He found that three fine bright lines between E and *b*, shown on the plate at 66½°, 67°, 67½°, coincided with those of iron; and in place of the red hydrogen line C, he discovered a black band, which he considered an absorption-band, and states that it is better defined in wet than in dry weather.

In Austria, Professor Lielegg followed up this subject with great perseverance, and gave more extended accounts of the varying character of the Bessemer spectrum during the different stages of the process. His experiments were made at Gratz, where the spectroscope was afterwards used with great success in controlling the Bessemer process; but at Königshütte, where dark gray manganiferous iron was used, it was found that the indications which in other works so plainly determined the moment of decarbonisation were unreliable. In this case, the lines whose disappearance is to indicate the exact point of time for ending the process, disappear too soon. During the period in which the spectrum is brightest, among the glowing vapours and gases that stream from the converter, carbonic oxide, next to nitrogen, is most abundant, and it is for this reason that the first investigator, Roscoe, expressed himself as confident that the numerous lines of the spectrum were caused by this gas, although he could obtain no coincidence.

Brunner* states that "no part of the Bessemer spectrum is ever visible in the flame when the converter is heated for the first time after being re-lined, but that when the lining is not new, Lielegg's group of green lines (CO_7) appears in the spectrum, which then contains also the lines of potassium, sodium, and lithium." From which he concludes that this spectrum is not to be identified with carbonic oxide, but must be produced by other constituents of pig-iron. Others state that the Bessemer spectrum is sometimes visible while the converter is being heated after a blow. I made an observation of the flame from the converter while it was being heated the first time after being re-lined, and obtained with great distinctness the potassium, lithium, and sodium lines, but have not under any circumstances detected any other lines while the converter was being re-heated.

* Read at the Troy Meeting of the American Association for the dvancement of Science.

* Van Nostrand's *Eclectic Eng. Mag.*, vol. i., page 508.

Lichtenfels, by a series of simultaneous comparisons of the manganese with the Bessemer spectrum, found the lines in the blue and green fields to completely harmonise in the two spectra. The violet manganese line which had been seen by some he could not detect in either of the spectra. I have never observed it, but Dr. Wedding, who has summed up the observations of others, states that he has repeatedly seen it. Its position is at 135¼°.

The instrument used in my investigations was constructed by Alvan Clark, of Cambridge, and consists of an equiangular flint-glass prism, in a metallic box, into the sides of which at the requisite angles are screwed an inverting telescope with a magnifying power of six, and a tube containing the adjustable slit and lens for rendering the rays parallel; also a tube with a scale, which is placed at such an angle that it is reflected from the surface of the prism through the telescope to the eye; it can be so adjusted as to appear along the upper edge of the spectrum. I was provided with Bunsen's plates of spectra on a large scale, and in order to adapt them to the scale in my instrument, I took the spectrum of the sun and obtained Fraunhofer's lines with great distinctness. Two characteristic lines in the solar spectrum were then noted, one of which appeared at 37° and the other at 117°, and a space measured equal to their distance apart as given on Bunsen's scale. This was divided into eighty equal parts, and the division extended in both directions. By the application of this scale to Bunsen's, I found that the remainder of Fraunhöfer's lines in my instrument exactly coincided with their position on his plates. The correctness of the new scale was also proved by other coincidences. By moving the prism, Fraunhöfer's lines will vary slightly in their relative distances apart, but in no possible position in which I could place the prism could I obtain the sun-spectrum as given by Wedding in connection with the Bessemer spectrum; if the spectrum given by him was obtained by the use of bisulphide of carbon in his prism, that substance causes a greater variation than I had supposed.

I have recorded the results of twenty-five observations on the Bessemer flame, most of which were taken at a distance of about thirty feet from the flame, though I have stationed myself at intermediate points between that and the flame; at one time sitting so close as to be almost scorched. Nearly all my observations were made at night and the lines obtained much better defined than when seen in diffused sunlight:

The record of my observations was kept as follows:—Five columns were ruled, headed—

Degree.	Colour.	Brightness.	Time.	Remarks.

Note was made of the dark bands as well as the bright ones, both of which were classed according to their distinctness, as very bright, bright, faint, and very faint. In the time column was noted the number of minutes after the commencement of the blow at which the lines appear.

At the first two or three observations I attempted to make a thorough note of the changes as they occurred throughout the whole spectrum, but afterward abandoned it as utterly impossible, as at the beginning of the second period, the lines come in so fast and the changes are so rapid that they cannot be accurately noted at the exact moment of their occurrence. I therefore confined myself to a few degrees at each observation, and by this method was enabled to note accurately, and at the exact moment of their occurrence, slight changes which otherwise might have escaped notice. Note was also taken of the changes in the general appearance of the whole spectrum during the successive stages of the process. After having made half a dozen observations, while viewing the spectrum of the flame from the converter while it was being heated for another charge, it was discovered that a movement of the eye before the eye-glass occasioned a similar movement of the lines of the spectrum along the scale, on which their position could thus be made to differ more than half a degree. I have seen no notice of this in the statements of others, and it may account for some of the apparent discrepancies. Thereafter, when taking the readings of any of the lines, the position of the eye was so adjusted as to bring the sodium line exactly at 50°. Owing to the extreme brilliancy of the flame the aperture may be made exceedingly narrow, and thus the many lines of the spectrum, which with a duller light and broader gauge would be blended together, may be separated.

At the beginning of the blow, the spectrum is continuous and very faint, and generally extends from 35° to 120°, covering about three-fourths of the length attained in the second period. This increases slightly in extent and brightness until the appearance of the sodium line. This line appears at the end of the first period at the beginning of a more decided flame. It comes flashing through from one extremity to the other for an instant, and then disappears only to return the next instant in brighter flashes, which are continued for about a minute, by which time the line becomes permanently established. On one occasion the sodium line, instead of flashing and disappearing as usual, continued visible after a few seconds, and expanded and contracted in width almost isochronously until it became permanently established. The appearance of this line indicates the termination of the first period. This period I have found to vary in extent from three to seventeen minutes in blows lasting from thirteen to twenty-seven minutes. None of the other lines make their appearance in vivid flashes as does the sodium. The lithium line becomes visible three or four minutes after the first flash of the sodium. It is very faint at first but soon becomes quite distinct, and lasts through the blow. The vivid flashing of the sodium line may be accounted for by the exceedingly small amount of sodium required to produce its spectrum—an amount not exceeding 1-180,000,000th of a grain. The slightest momentary combustion taking place in the stream of gas from the converter, would at that instant render glowing a sufficient amount of the vaporised sodium to produce its spectrum, and thus occasion the flashes so characteristic in the first appearance of that line. Lithium exists in a much smaller quantity, and requires 1-6,000,000th of a grain, or thirty times that given for sodium. By the time the lithium line is established the red potassium line at 23¼°, and occasionally the violet line at 135°, appear, and the blue and green fields become divided into bands, which are so rapidly resolved into bright and dark lines, that it is difficult to note the exact time of the appearance of each. The spectrum increases to a dazzling brightness, and extends itself in both directions until it reaches from 23¼° to 140°.

During the third period the spectrum becomes more brilliant, and the lines more distinct. Several new lines make their appearance in different parts of the spectrum, of which the ones at 51½°, 57°, and 67° are well defined, while others are faint and not always visible; some of them appearing only toward the close of the last period. In viewing the lines in the most refracted part of the spectrum, it has been repeatedly observed, both by myself and others, that these lines were more strongly marked when entering the eye at an angle than when viewed directly. That this was not imagination is proved by repeated identification of lines at the same point on the scale.

At the termination of the blow the lines are rapidly swept away, sometimes in the inverse order of their appearance, but more generally they disappear within the space of two or three seconds, leaving a continuous spectrum as at first, though somewhat brighter. Sometimes the sodium and lithium lines are swept away with the others, and at other times they remain visible. In either case the change is very decided, and does not generally occupy more than three seconds. In the course of my observations, thirty-three lines have been detected, as given in the table below.

Some of the lines given by Lielegg I have failed to find, but have detected others not given by him.

1st Period, 23½, 35, 50, 135.
2nd Period, 23½, 35, 43, 44, 44½, 45½, 46, 47½, 48½, 50, 52, 53, 56, 56½, 61½, 62, 62½, 63, 65, 66½, 67½, 70, 72, 120, 135.
3rd Period, 23½, 35, 43, 44, 44½, 45½, 46, 47½, 48½, 50, 51½, 52, 53, 56, 56½, 57, 61½, 62, 62½, 63, 65, 66½, 67½, 70, 72, 100, 102, 103, 105, 108, 135.

Among the dark bands detected, the most intense occurred at 44—46, 51—55, 56—58, 62—64½; others were found at 33—34½, 36½, 37½, 38½, 40, 68—72.

Many of the dark bands were crossed by bright lines.

I have repeatedly observed the dark band considered by Roscoe to be a hydrogen absorption line, but have not noticed that its intensity varied with the dampness of the weather. Whether it is an absorption-band or not can be determined by a series of observations continued through wet and dry weather. If this proves to be a hydrogen line, the Bessemer spectrum will be found more complicated than is generally supposed. It has been thought by some that the dark bands in the spectrum are absorption lines due to the cooling of the outer sheath of flame, but it is more probable, that although the pellets of iron and slag tend to produce a faint continuous spectrum; yet in contrast with the very brilliant lines it appears discontinuous, the dark bands being merely intervals between the bright ones. The iron spectrum has not been satisfactorily identified. It has been suggested that the brightness and size of the lines of the Bessemer spectrum do not allow the iron lines to appear. In comparing the Bessemer spectrum with Bunsen's spectra of nickel, cobalt and calcium, no coincidences were observed except two or three in the latter spectrum. The brightest calcium line, however, was not visible in the Bessemer spectrum. The Bessemer spectrum contains yet many mysteries to be solved, among which is the cause of the non-appearance of the lines of the spectrum at the beginning and termination of the blow.

This was readily solved when the numerous lines of the spectrum were attributed to carbon, but in proving them to be caused principally by manganese, their disappearance is not so readily accounted for.

One theory to account for it is that the luminous power of the flame is too small at the beginning and end of the process to produce a spectrum. In regard to this it may readily be shown that the brilliancy of the spectra of incandescent metallic vapours does not depend upon the illuminating power of a flame, but upon the heat of the flame into which they are introduced. For instance, the spectra are more distinct in the non-luminous flame of a Bunsen lamp than in the ordinary luminous gas-flame. If we take the theory as referring to the feebleness of light given off by those substances in the flame which produce the spectrum, it will resolve itself into the one of change of temperature, notwithstanding the fact that the illuminating power of flames of the same temperature varies with the composition of the gas, because there is evidently enough sodium in the flame to give its characteristic line; hence, whatever might be the illuminating power of the flame, if the heat is sufficiently intense the sodium line *will* show itself.

Dr. Wedding adopts the theory that the absence of the spectrum at the beginning and termination of the blow is because the absolute quantity of the bodies volatilised producing the spectrum is at these times too small. His reasons for holding this view are as follows:—"A trace of sodium will give its characteristic line, but, according to Simmler, a much larger quantity of manganese is needed to obtain a recognisable reaction than that which can be detected by the well-known blowpipe reaction with carbonate of soda. Consequently, spectrum analysis does not depend alone upon the *presence* of a body, but also upon the presence of a certain quantity. And although manganese is always left in the iron, it may not be left in sufficient quantity at the termination of the blow to produce the spectrum, and for this reason the lines disappear."

To this theory there are some strong objections. 1st. If we take the manganese in sufficient quantity, and hold it in a flame the spectrum will increase in brightness until a uniform temperature is attained; but when the amount of manganese vapourised begins to diminish, its spectrum will gradually decrease in brightness until it disappears. Now, if the disappearance of the manganese lines in the Bessemer spectrum is owing to the diminution of the quantity of manganese, we should infer that these lines would gradually grow more indistinct and then fade away; but, on the contrary, the manganese spectrum increases in brilliancy from its first appearance, and is more intense just before being swept away than at any other time. The analysis of the smoke, which appears when the flame ceases, proves that a considerable quantity is still volatilised, and it is notable that in manganiferous iron this quantity increases towards the close of the blow. 2nd. It would be more difficult to account by this theory for the non-appearance of the sodium line at the beginning of the blow, as sodium then in all probability exists in the issuing gas in sufficient quantity to produce its spectrum at a high temperature, as it is only by special precaution that we can keep it out from any flame. 3rd. A still greater difficulty would arise in applying this theory to the spectra of sodium and lithium at the close of the blow. As has before been stated, these lines sometimes disappear at the moment of complete decarbonisation, and sometimes remain. In the former case, to say that our friend sodium had given out would be doing great injustice to that element, as it has never given us reason for bringing so grave a charge against it. Dr. Wedding, in attempting to demonstrate that the non-appearance of the manganese lines is owing to the lack of sufficient quantity volatilised to produce its spectrum, makes the following statements:—

From analyses made by Brunner we find that the manganese contained in the iron falls from 3·460 per cent in the raw material, to 1·645, 0·429, and finally to 0·113 per cent in the decarbonised product; and that the protoxide of manganese in the slag first increases from 37·00 per cent to 37·90 per cent, and then sinks to 32·23 per cent, and furthermore, that a certain quantity of manganese is to be found in the smoke. How much manganese is really lost by volatilisation cannot be determined, since data are wanting as to the absolute quantity of slag and iron; consequently we cannot determine how much manganese has been lost by means of the eruptions.

But since the manganese contained in the pig-iron decreases constantly, and that contained in the slag after the termination of the boiling period also decreases, a considerable volatilisation of this body is probable just at the time when the spectrum is best developed. Comparing with this the experiments that can be made in the laboratory we arrive at the hypothesis, that the oxidised manganese which has entered into the slag is not volatilised but is retained by the slag; it can, therefore, get into the flame only in the shape of solid or fluid combinations.

In the above statements the results of the analysis prove that some of the manganese in the slag is volatilised. We cannot consider the manganese spectrum during the entire process as due wholly to the volatilisation of the manganese directly from the iron, for while the amount eliminated from the iron grows continually less, the manganese spectrum grows brighter. Owing to the intimate mixture by the blast of the iron and slag, the manganese oxide contained in the latter is brought in contact with the melted iron and vapourised. This mixing of the slag and iron would cease at the termination of the process, and this would account for the sudden diminution of smoke.

If there was a sufficient carbonic oxide flame to render the escaping gases glowing it is evident they would not issue from the converter as dark smoke, but as incandescent vapour having its characteristic spectrum. The lack of sufficient flame may, therefore, account for the disappearance of the manganese spectrum. The Besse-

mer flame presents other problems, and opens an intensely interesting field for scientific investigation; and by the use of more delicate instruments than have yet been employed for this purpose, discoveries may be made which will throw new light upon the subject of spectrum analysis.—*American Journal of Science.*

ELECTRO-MOTIVE FORCE.

By the Rev. H. HIGHTON, M.A.

The subject of electro-motive force is so important, and the prevalent idea, that only a definite amount of work can be got out of a definite amount of chemical changes, has so completely blocked the way against a true consideration of the subject, that I think it may be useful if I make a few remarks on the nature of this force.

Let me first contrast it with the force of attraction of gravitation.

There is then, *first*,—this wonderful difference; that the force of gravitation between two bodies varies inversely as the square of the distance between them, whereas electro-motive force is equal at all distances. The electro-motive force, developed between a plate of zinc and one of copper, 1-10th of an inch apart, is exactly the same, neither more nor less, than if one is in America, and the other in England; and if one were on the earth, and the other in the sun, or in the most distant fixed star, there is no reason to suppose it would be any less. This is a fact which will, of course, be acknowledged by every electrician, but I may as well say that I have tried a plate of zinc, placed at 10 miles distance from a plate of copper, and found the electro-motive force exactly the same as when they are 1-10th of an inch apart. If we could cut the earth into two hemispheres by an insulating plate we could transmit any amount of force, or any telegraph message, from any point in one hemisphere to any point of the other without the slightest difficulty. The resistance in that case would be next to *nil*; and as the magnetic and chemical forces transmitted by a circuit are only limited by the resistance of the circuit, almost any amount of power could be transmitted. As we cannot thus cut the earth in two by an insulating plate we are obliged in transmitting magnetic or other power from England to America to use the sphere of the earth for one-half of the circuit, and an insulated wire for the other half; and it is the resistance of this wire which limits the amount of force transmitted. Similarly, on the supposition of being able to form a circuit by cutting into two insulated hemispheres the sphere of stellar space, we could transmit any amount of magnetic force to the furthest star. Nor is this case wholly an imaginary one. As a matter of fact, we have in nature an instance of two enormous conductors with an insulating band between them. There is the earth and sea, which form one conductor; and at a certain distance from them there is a second conductor, consisting of the upper and rarefied strata of the atmosphere, with an insulating band of denser air between them. Now, when, from unknown causes, the electric equilibrium between a pole and the zenith is disturbed, a current passes from the zenith to the pole through these rarer strata of the air, and a corresponding current passes through the earth and sea in an opposite direction. This, of course, is the well-known phenomenon of the aurora with its corresponding earth currents which are so annoying in the electric-telegraph. Whether the circuit is completed through vertical strata of the atmosphere at the equator and the pole, rendered conducting by vapours or other means; or whether there are simply two electric discharges from the zenith to the pole, one in the upper regions of the air, the other in the earth and sea, acting inductively on one another, we cannot be sure. It may be right to add that in reality the force of gravity is the same at all distances; but inasmuch as it is a force radiating from a centre, the portion which acts on any given surface varies inversely as the square of the distance, because the whole force extends itself over a space varying as the square of the distance, and, therefore, a given surface receives so much less of it at a greater distance; but the force itself is equal at all distances.

Secondly. There is this important difference between gravity and electro-motive force; that the one acts only in straight lines, whereas the other appears to be wholly indifferent how tortuous its course may be. Provided only there are two channels of communication between two metals; one forming a liquid communication, and the other a metallic or gaseous conductor; the straightness of the two channels makes very little difference.

Now observe the enormous practical importance of this point. Suppose we want to avail ourselves of the force of gravity as a motive power to do work. The work produced is as the mass on which it acts multiplied by the space (or square of the time) through which it acts. Thus, if we use it to move clockwork, and want it to make the clock go for a very long time, we must raise a given weight to a proportionate height; and the more power we want to get from it the higher we must raise the weight in the first instance. Then, the force of gravity, acting through a longer space and longer time, will produce so much more work; and the work done is in proportion to the perpendicular height to which the weight is raised, measured in a straight line. But if we want to increase the work we can get out of the electro-motive force of a pound of zinc, and for this purpose increase the time and space through which it acts, we may place it as near as we like to a plate of copper (indeed, the nearer the better), and increase the space and time through which the electro-motive force acts by convoluting in any way the wire which connects the two metals. In this way, by increasing the length of the conductor, and so increasing the space and time through which the electro-motive force acts, we can increase, to any extent, the work obtained. And it is in this way, and owing to this peculiar property of electro-motive force, that we can get any amount of work whatever even from a single grain of zinc. It is strange, but it is true. Scientific men have hitherto (generally, though by no means universally), failed in recognising this wonderful fact, in consequence of that most fallacious idea of a definite mechanical equivalent of heat. It is surprising how it has grown into a common axiom with scarcely the slightest foundation in fact. Not a few scientific men have asserted, more or less directly, that the power to be got from electro-motive force is without limit; but of late years they seem to have been driven out of their position by the assumption of a definite mechanical equivalent for heat and chemical change. I have entered more fully into this question in the January number of the *Quarterly Journal of Science*, but let me here give a single fact which wholly overthrows the supposed action—at least in a practical point of view.

Take three cylinders and pistons; one filled with atmospheric air, another with vapour of water (or steam), and the third with vapour of turpentine. Impart to each a definite number of heat-units or calorics. This amount of heat will produce, say, one unit of work, or will raise an unit of weight one unit of height by means of the third cylinder and piston; but in the first cylinder and piston it will raise the same weight ten times as high, and in the second 6·6 times the same height. Of course, it is easy to answer that in the one case it has also expanded vapour of turpentine, whereas in the other cases it has only expanded steam or air, and that this is to be considered as work. But the answer is simple; that if this be work, it is not work in the ordinary and practical acceptation of the term, namely, units of weight raised units of height.

I will show at another time how the work done by a given quantity of heat may be increased indefinitely.

Putney, December 18, 1870.

EXTRACTION OF POTASH FROM THE "SUINT" OR POTASSIC SUDORATE IN SHEEP'S WOOL.*

By J. LAWRENCE SMITH.

THIS source of potash is not known in this country, and hardly anywhere else than in a certain part of France. Potash from this source formed an article of exhibition in 1867, as well as in 1862, and as the source is a curious one, and the process of obtaining it is not generally known, there is sufficient reason for describing it to the American technologist somewhat in detail. The nature of this source of potash was reported on in 1862, for the London Exhibition, by Hofmann, and free use has been made of this description.

It is well known that sheep draw from the land on which they graze a considerable quantity of potash, which, after circulating in their blood, is excreted from the skin with the sweat, in combination with which it is deposited in the wool. Chevreul pointed out that this peculiar compound, by the French called "suint," forms no less than a third of the weight of raw merino wool, from which it may be readily dissolved out by simple immersion in cold water. In coarser wools it is less abundant, and, according to MM. Maumené, and Rogelet, the potassic sudorate or suint of ordinary wools forms, on the average, about 15 per cent of the weight of the raw fleece.

This compound was formerly regarded as a soap; doubtless because wool contains beside the suint a considerable proportion (about 8½ per cent) of greasy matter (Chevreul). This grease, however, is, in fact, combined with earthy matter, chiefly lime, as an insoluble soap. The soluble sudorate is, according to MM. Maumené and Rogelet, a neutral salt, resulting from the combination of potash with a peculiar animal acid, of which little is known beyond the fact that it contains nitrogen.

At the great seats of the woollen manufacture in France, as at Rheims, Elbœuf, and Fourmies, the new industry of MM. Maumené and Rogelet is either established or in course of establishment. Their plan is to buy of the woollen manufacturers the solutions of suint obtained by the immersion of their raw fleeces in cold water; paying higher, of course, for those liquors in proportion as they are stronger; thus, for example, for the suint from a ton of wool they pay five francs, if diffused through 27 hectolitres of water (sp. gr. 1·030); whereas, for the same quantity of suint they can afford to give no less than 18 francs, if it be concentrated in 3 hectolitres of water (sp. gr. 1·250); and so in like proportion for the suint liquors of intermediate strength.

An ordinary fleece, weighing 4 kilogrammes, contains, according to MM. Maumené and Rogelet, about 600 grms. of sudorate of potassium or suint. This, according to their analysis, should contain 33 per cent of its weight, *i.e*, 198 grms. of pure potash. Of this, according to another estimate (showing the nitre it would produce), they appear to reckon on about 173 grms. as being practically recoverable.

The wool manufacturers of Rheims wash annually 10,000,000 kilos. of fleeces, those of Elbœuf 15,000,000 kilos., and those of Fourmies 2,000,000 kilos.—total 27,000,000 kilogrammes, the produce of 6,750,000 sheep. From this quantity, were it all subject to MM. Maumené and Rogelet's treatment, 1,167,750 kilos. of pure potash would, according to the above ratio, be recoverable. The value of the potash, as carbonate, reckoned at the average price of American potash, would range between 400,000 dols. and 450,000 dols. The wash-water yielding it, if paid for at MM. Maumené's and Rogelet's minimum price, would cost about 100,000 dols. Hence it appears that the process of MM. Maumené and Rogelet may be worked on a large scale and with very ample profit. MM. Maumené and Rogelet compute that there are 47,000,000 sheep in France—nearly seven times as many as those above calculated on. And they point out that if the fleeces of these were all subjected to the new treatment France would derive from her own soil all the potash she requires; enough, they observe, to make 12,000,000 kilos. of commercial carbonate of potash, convertible into 17,500,000 kilos. (about 17,500 tons) of saltpetre; with which, as they characteristically add, 1,870,000,000 cartridges could be charged. The difficulty of collecting the wash-waters of fleeces, scoured in small numbers by the farmers all over the country, is a great bar to such an extension of the process.

* From "The Progress and Condition of Several Departments of Industrial Chemistry," by J. Lawrence Smith.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from vol. xxii., p. 317.)

LECTURE III.

IN referring, at our last meeting, to the place in nature which ought to be assigned to these little organisms of which we have been speaking—the ferments—I stated one ground which appeared to me conclusive, or very nearly so, in favour of placing them in the animal and not in the vegetable kingdom. That ground was a chemical one, viz., that these organisms assimilate, or to use a homely phrase, they feed upon very complex substances, and they give off, during their vital functions, less complex substances. That circumstance appears chemically conclusive in favour of their being rather animals than plants, for plants build up complex substances, and animals assimilate the products which plants have formed, and break them up into simpler ones. There are, however, two other considerations which I think are of such importauce that it would be undesirable to pass them over, which tend in the same direction, and are striking confirmations of the conclusion to which we then came. The one is that, whereas plants require for their growth the light of the sun—in fact, their very growth is a process of absorption of heat by their leaves from the rays of the sun—and plants by doing so render heat latent, as we sometimes express it, that is, they cause an apparent disappearance of heat, and lower the temperature of the surrounding space; animals, on the contrary, give off heat during the exercise of their vital functions, and do not need to be exposed to heat or to continuous light for their growth. Now, in both these respects, as in the other respects, these little cells, the ferments, appear to be distinctly animals. I do not know of one case of a ferment requiring or using for its vital processes the light of the sun; they usually grow, and they seem to thrive quite well, in the dark. Again, there are well-known cases in which, during their vital functions, they evolve or give off heat, so that I think these are very overwhelming reasons for not considering them as vegetables in their functions, but rather as animals or animal atoms. I have on the table here three or four liquids, which are in states of fermentation, of which I have already had occasion to speak several times. This first carboy contains an extract of malt, to which common cane sugar has been added, and some brisk, thriving yeast was then introduced. Effervescence is now rapidly going on, as you may hear by the gas—carbonic acid—which is escaping through the bent tube into the vessel containing lime water. This liquid contains little soft, nearly round particles, which I was just speaking of as animals, though they certainly do no look like animals. The second flask contains another substance, of which I also spoke the other evening. There is here what I might call gastric juice—it is a mixture made for the purpose of getting lactic acid from sugar. Some pepsine was made to digest a certain quantity of white of egg,

† The Cantor Lectures. Delivered before the Society of Arts.

and to that mixture, whilst still acid, I mixed with some common cane sugar, and put into it some alcoholic ferment, or common yeast. A good deal of the yeast was digested; it disappeared, and was dissolved. I thereupon put in more and more, until there was an excess of it left in the flask. It was then kept for upwards of a week in a box, which I have been using for the purpose of these fermentations—a metallic box, which is kept, by means of a regulated gas-burner, at a temperature of about 30° centigrade, or a little above blood heat. During that time the substance has been gradually undergoing a change or fermentation. It became strongly acid, and I then added a base, at one time potash, and afterwards powdered marble or carbonate of lime, which was dissolved by the acid, and thus a quantity of lactic acid was formed. Here also there are little cells, which, under the microscope, can be seen to be different from those in the first mixture. They are smaller in their dimensions, but yet they present no very marked individual characteristics by which they can be identified. Indeed, the chief, or, I may almost say, the only thing by which we can certainly identify any one of these organisms is by setting it to work, and by seeing what work it performs. In the third carboy I have a mixture which had gone through the phase I have just been speaking of. It contained some sugar with lactic ferment, but when all the sugar had disappeared, and was transformed into lactic acid, I left the carboy in the same warm chamber, and another fermentation has set in, and there is already a considerable quantity of the substance called butyric acid present, and the greater part, if not the whole, of the lactic acid has already passed over into this butyric acid. Here, in this glass dish, there is another ferment still, although, unfortunately, it has got disturbed in coming here. It contained a decoction of yeast, with which was put about two per cent of pure vinegar, and about four per cent of alcohol, and I then touched the surface of the liquid, which was perfectly clear, with a glass rod which had been in contact with the vinegar-plant, and left some little particles floating on the surface of the liquid. These little particles, in the course of a day or two, spread over the liquid, and when this vessel came from University College this morning, it was covered with a perfectly uniform film, consisting of little cells, different from each of the others to which I have called your attention, and quite distinguishable under the microscope. I should state that, after the mixture was first made, and after the vinegar cells were put into it and allowed to grow on it, I supplied them with some additional food twice. On one occasion I added a somewhat larger quantity of alcohol than was intended, and the effect was that the cells were most injuriously affected. They constituted a dense, smooth, white film, and this seemed almost to disappear, and on examination under the microscope it was found that they had shrunk—in fact, they had been killed by a too strong dose of alcohol. This was then allowed to evaporate, and the vinegar cells very soon again spread over the liquid. I will now commence, in another dish, a similar experiment. I have in this bottle a mixture of yeast-water and alcohol, with a few drops of acetic acid in it. I will pour this into the glass dish, and then put on to the surface some of these little ferments, which I have here, and I have no doubt that, if we allow this mixture to stand, we shall find, by our next meeting, that it will be covered over with a smooth film, consisting of vinegar cells, which will be transforming the alcohol into acetic acid. I may show you the strength of the acid in this last instance by putting into it a slip of blue test-paper, which you see is immediately coloured a deep red.

With regard to the process by which these cells are propagated, some exceedingly interesting experiments have been made under the microscope. Professor Mitcherlich and various others, Pasteur among them, have put little alcohol cells under the microscope, putting them first into a liquid upon which they could feed, and they have noticed that the cells, or some of them, gradually swelled out at one side—that a little wart, if I may use the expression, made its appearance on one side; that this increased in size until it became as large as the original cell, and then it became detached. The propagation of the alcohol cells, the wine ferment, has been seen by several observers to take place by a process of budding. I will show you the growing cells, by throwing on the screen, by means of an oxy-hydrogen lantern, a photograph of the wine ferment, some of which will, I believe, show a little excrescence at the side, and the general arrangement of the cells will be easily detected. This is a photograph from a plate of M. Pasteur's, and conveys an exact representation of the appearance which the alcohol cells ordinarily present. I will now show you the photograph of the acetic ferments, and the difference in the general appearance is very striking. When examined carefully, it will be found that these little vinegar cells are in couples; little masses about twice as long as they are broad, and by degrees they become strangulated at the waist, and ultimately separate. With a considerable magnifying power it has been found that the wine cells contain granulated particles, but exceedingly little is yet known of their structure. Certainly one of the most promising directions for investigation in the phenomena of life is presented by the spacing study of these various little organisms, which we have so completely under our control.

With regard to the processes by which these cells are propagated, I have mentioned already that when certain liquids, capable of undergoing decomposition, are exposed to the air, that little cells gradually make their appearance in what was at first quite an unaccountable manner. It was long supposed, and on very good authority, that the oxygen of the air was the active agent in transforming a fermentible substance into these little cells; and Gay-Lussac, one of the ablest of French chemists, who died some little time, made some very careful experiments with a view to decide that point. They led him to the conclusion that oxygen was all that was needed in order to initiate the process of fermentation in the juice of grapes, which by itself does not ferment. It is worth while to state, in general terms, the nature of these experiments. He put into a glass vessel, closed by mercury, a small quantity of grape-juice, which was expressed under mercury, so that it did not come in contact with the air on its way into the glass jar intended to receive it. This was then kept closed for some time without change. He then introduced oxygen, sometimes from the atmosphere—I am now giving you an account partly of what was done by Gay-Lussac, and partly what was done by others—and sometimes the oxygen was derived from potassic chlorate. Air was used which had been passed through red-hot tubes, so that any vital organisms in it must have been destroyed before reaching the grape-juice; and it was found that, in these cases, the access of the air to the substance did induce the formation of yeast cells and did induce a process of alcoholic fermentation in the liquid by their growth. The conclusion, therefore, appeared to be established that oxygen was all that was needed for the process. Since that time, however, other experiments have been made, with precautions which were not observed by Gay-Lussac; and I must especially quote a truly masterly investigator, Pasteur, whose extraordinary researches in this subject have certainly constituted an important era in our knowledge of it: Pasteur has made a great number of experiments, partly such as those which had been made before, and partly fresh ones, of which I will describe a few characteristic samples. For instance, he took little glass bulbs, with a long neck bent in several places, like the one I hold in my hand. This little bulb contains some yeast-water, and also about 10 per cent of sugar, a mixture which is peculiarly susceptible of undergoing fermentation and decompositions of various kinds. When this was introduced into such a bulb, Pasteur boiled the liquid for some time, so that any

little living particles which might have entered the bulb with the liquid, by being exposed to the temperature of boiling water, might be killed, and also that any particles which might be lodged in the neck of the flask would be similarly treated and killed. Some of these bulbs he closed, sealing up the tubes whilst still full of steam, and he then put them by in a warm chamber, similar to that which I just now alluded to as being of the temperature of 30° centigrade, so that they should be under the conditions most favourable to the development of any little living organisms, if such could develop themselves. He so kept them for days, weeks, and months, and I am not sure that he did not keep some for years, and at the end of the whole time he found that in no case was there the production of these vital organisms. I told you that when the tube was closed the vessel was full of steam; of course that steam was condensed on cooling, and left a partial vacuum above the liquid, and when Pasteur opened the tube by breaking off the point, the air rushed in violently to fill the vacant space. He found that in almost every case, although not in all, after this air had rushed in, a process of decomposition commenced, and in some cases he found little animalcules, and various kinds of mould in others, and he has described a considerable number of different organisms which he got in different bulbs in that manner. It so happened, also, that in one case the tube, I think accidentally, at first remained unsealed, that it was not kept from contact with the air as the others were; still, to his amazement, Pasteur found that even in this one which remained open there were no organisms, that it remained as unchanged as those which were sealed up. Finding this, he repeated the experiment many times, making a great number of bulbs similar to the first, putting some of that same liquid into them, and boiling the liquid for some time, so as to destroy any organisms; but, when they had been killed, he left the bulbs open, and he found that the contents were as effectually protected by the conditions there present as if the tubes had been sealed. He submitted the results to several members of the French Academy; the experiment was repeated by other persons, and the results showed—if there were any exceptions I do not remember hearing of them—that no organisms were produced. You will notice that the liquid which had been boiled was separated by a long, thin tube from the outer air, and the air only had access to it through this long, narrow, tortuous passage, which, moreover, was at first wet inside, because of the condensed steam. Pasteur then cut off some of the tubes, so as to allow free access of air to the contents, without having to pass through this long narrow tube, and soon after that was done the process of decomposition set in, and he got various organisms formed in his mixture, which developed themselves in the way yeast, mould, and such-like organisms generally do.

I will now leave these experiments for the present, in order that I may tell you of some other discoveries, which will afford a key to them.

(To be continued).

NOTICES OF BOOKS.

Louisville Academy of Science.—The Journal of Science. Published under the auspices of the Louisville Academy of Science. Louisville, Ky. U.S.: L. Bell and Co. 1870.

Under the above titles, we have received two small pamphlets, the first of which is essentially the prospectus of a new scientific institution just established in the city of Louisville, Kentucky, a place of over 100,000 inhabitants. The object of this institution is to afford a pleasant resort for those of the citizens who are willing to encourage scientific investigations. The intention is to provide a course of lectures on the subjects of pure and applied chemistry, natural philosophy, astronomy, geology, botany, natural history, anatomy, physiology, hygiene, mental and moral philosophy, history, literature, and language. We learn also that a museum and library are to be formed, and the main portion of the first of the above-named pamphlets is occupied with a tabulated review of the course of lectures to be given during the session of of 1870-71. The second pamphlet is not as might be inferred from its title the first regular number of the "*Louisville Journal of Science*," but simply a small specimen number, exhibiting more the style of the work than what the work itself will be, because this will be regularly published every month, beginning with the 1st of December 1870, and will contain the lectures and papers read before the Louisville Academy of Science, with the latest important transactions of similar institutions. From the excellent mode in which this specimen number has been got up, we think the Louisville Academy of Science may, as has been the case with many similar institutions in the Great Transatlantic Republic, become an excellent means of imparting sound scientific as well as generally useful knowledge; for this is the great desideratum for the masses of the people.

CORRESPONDENCE.

EXAMINATIONS IN CHEMISTRY.

To the Editor of the Chemical News.

Sir,—As you have kindly allowed the interchange of opinions on examinations in practical chemistry I desired in my former letter to take place through the Chemical News, it devolves upon me to commence the interchange.

It will not be denied that practical examinations in purely experimental sciences, *if they are given at all*, play a very subordinate part in the examinations in these sciences, and this at a time when examinations are so extensively employed as tests of proficiency. Hence, compared with the written examinations, very little thought or attention has been devoted to them; consequently they are not in unison with the present state of these sciences. In chemistry very little has been done beyond giving examinations in qualitative analysis, and these examinations are frequently so trivial that they are limited to one or two bases, and the like number of acids.

I recently conducted in this college some examinations in practical chemistry. I gave to the junior students a complex mixture, to be examined qualitatively; to the more advanced students one in quantitative analysis, and one in assaying. The remarks which follow apply to the two latter examinations. In both cases the students were limited as to *time*, and there was *variety* as regards the substances to be estimated. I intended to make these examinations, as regards conditions, &c.—and I think I succeeded in making them—more severe than those a young chemist would encounter if he was engaged as an assistant to an analytical chemist, or if he was appointed chemist in some chemical manufactory. And in this point of view I have not seen any examinations equal to them; not even the practical examinations for the degree of Doctor of Science in the London University, which are the most advanced I have seen, although I think far inferior to what they ought to be for such a degree examination. It is in the extent and conditions of the examinations I think an interchange of opinions would be so useful. I send a copy of the printed papers as being the most satisfactory mode of proceeding. In the instructions it will be seen that six hours were allowed for both papers, but I may add that they were completed by the students in five hours, and most satisfactorily.

Subject—Quantitative Analysis—Practical Examination.

General Instructions.—The same value is attached to each determination. Six hours are allowed for the

analyses. The percentage amounts of the substances to be determined to be given in each case.

(1). Find the amount of chlorine in the sample of chloride of lime given you, by means of a standard solution of arsenious acid.

(2). Determine by means of the polariscope the amount of sugar in the sample of cane sugar given you.

(3). Estimate the amount of soluble phosphate in the sample of superphosphate given you.

(4). Find the "original gravity" of the *porter* given you for examination.

(5). Determine the amount of *peroxide of manganese* in the sample of manganese ore given you.

Subject—Assaying—Practical Examination.

General Instructions.—The same value is given for each assay. Six hours are allowed for the assays. The percentage amounts of the substances to be determined to be given in each case, No. 4 excepted.

(1). Determine by wet assay the quantity of iron in the sample of iron ore given you.

(2). Determine by dry assay the quantity of lead in the sample of lead ore given you.

(3). Determine by cupellation the quantity of silver in the button of lead obtained in the lead assay.

(4). Determine by Lewis Thompson's method the absolute heating power of the sample of coal given you, and state how much water at 212° F. will be converted into steam by the coal.

(5). Determine by wet assay the quantity of copper in the sample of copper ore given you.—I am, &c.,

Robert Galloway.

Royal College of Science, Dublin,
December 27, 1870.

THE SEWAGE QUESTION.

To the Editor of the Chemical News.

Sir,—Will you kindly give me space to point out some mistakes into which Mr. Stanford has fallen with regard to my "Digest of Facts" relating to the sewage question?

It is *not* "the Report of the British Association Committee," nor is it true that it anywhere "pretends to be a synopsis of its views." It does not (*i.e.*, the first edition did not) contain the results of the work of the committee, which will be published shortly in their Report, but is a "Digest" of the most important ascertained facts, prepared at the suggestion of the committee, to save persons who wish to study the subject the trouble of wading through the numerous blue-books, &c., in which the necessary information is contained.

As to the implication that it merely contains "in abstract what has been already published *in extenso* in a Government blue-book" at a cheaper price, Mr. Stanford's own subsequent remarks, and the fact that the work has been sufficiently appreciated by the towns to necessitate the immediate preparation of a second edition, sufficiently refute this.

I am not aware that I have anywhere stated that "our sewers must be porous to the drainage water above and impervious below." What I have stated is, that "it is certain that towns must be provided with *pervious drains*, and it is equally certain that they must be provided with *impervious sewers*." ("Digest," p. 132).

I do not wish to enter into any special pleading for or against any system, as my object has been, and still is, to collect the substantiated evidence from all sides, and if the balance of evidence should at any time turn in favour of a "dry" system, though I certainly see no probability of its doing so, I shall be the first to acknowledge it, as it makes not the smallest difference to me which system is ultimately adopted, so that it be the one which offers the greatest sanitary advantages.—I am, &c.,

W. H. Corfield, M.A., M.B.,
Professor of Hygiene and Public Health at University College.

Jan. 3, 1871.

MISCELLANEOUS.

The Royal Polytechnic Institution.—Professor Pepper and his co-Directors have, as is their usual custom at this festive season, provided a long and excellent programme for their visitors. This programme, which includes the lecture on the Continental war, in which the applications of modern chemical and mechanical science to military purposes are explained, will, we are sure, continue to attract large audiences.

Quantitative Estimation of the Non-Saponified Neutral Fatty Matter Present in Soap.—The soap, previously converted into thin shavings, is first thoroughly dried at 100°, and next boiled for a considerable time with petroleum naphtha, so-called benzoline of commerce in this country; but this fluid should be, previous to use, submitted to fractional distillation, and only the liquid which comes over at 86° applied for the purpose just alluded to. The ebullition of the weighed-off sample of soap has to be so arranged that the evaporating liquid runs back, after condensation, into the retort or flask; the use of the petroleum naphtha for this purpose is based on the fact that the fatty matter of soap saponified and combined with alkali is completely, or, at least, for all practical purposes, completely insoluble in this naphtha as instances the following examples:—11·3 grms. of Marseilles soap (previously dried at 100°) were boiled for several hours with benzol (pure) after the evaporation of the previously filtered liquid, there remained a quantity of 0·145 grm. = 1·2 per cent, the ash of which amounted to 0·002 grm. equal to 0·015 grm, or 0·13 per cent of soap, the rest being non-saponified fat; 8·197 grms. of soap treated with petroleum naphtha yielded 0·15 per cent, containing no ash at all. The use of ether, even if anhydrous, and of rectified sulphide of carbon are not suited for this purpose, because the alkaline stearates are, to some appreciable extent, soluble in these liquids.

The Glasgow Gas.—The following statistics regarding the illuminating power and purity of the Glasgow gas for the quarter ending the 31st of December, 1870, have been supplied to us by Dr. Wallace, F.R.S.E., Gas Examiner for the City.

	Townhead works.	Dalmarnock works.
Illuminating power of 5 cub. ft. per hour in standard candles, average	28·74	28·23
do. maximum	32·28	31·04
do. minimum	26·40	25·51
Sulphur, grains in 100 cubic feet of gas, average	12·68	12·25
do. maximum	18·32	17·88
do. minimum	6·28	5·23
Ammonia, grains in 100 cubic feet of gas, average	5·42	4·88
do. maximum	8·93	8·94
do. minimum	3·17	1·56

The two kinds of gas are tested daily (about 6 p.m.) at the same station, which is about a quarter of a mile from the Townhead works, and a mile and a half from the Dalmarnock works. The same mixture of coals is used in both works, and hydrated oxide of iron as well as lime is extensively employed in the purification of the gas. Not the slightest trace of sulphuretted hydrogen was observed during the quarter, except on one occasion, when a quantity of unpurified gas escaped accidentally into one of the holders, rendering the gas impure for several days. The gas-works of Glasgow belong to the City, having been acquired from the companies by whom they were erected about a year and a half ago. The illuminating power stipulated in the Glasgow Gas Act is 25 candles, but there is no limit defined as regards sulphur and ammonia. The price is 4s. 2d. per 1000 cubic feet.

THE CHEMICAL NEWS.

VOL. XXIII. No. 581.

ON FLUORIDE OF SILVER.*

By GEORGE GORE, F.R.S.

THIS paper contains an exhaustive account of the behaviour of argentic fluoride in vessels of platinum, carbon, and various fluorides in contact with chlorine, bromine, and iodine at various temperatures. When argentic fluoride is completely decomposed by chlorine in platinum vessels at a red heat, the reaction agrees with the following equation:—

$$4AgF+4Cl+Pt=4AgCl,PtF_4.$$

Vessels of cryolite and of fluor-spar were found incapable of retaining argentic fluoride in a melted state. Other vessels were also made by melting and casting various mixtures of earthy fluorides at a high temperature; and although forming beautiful products, probably capable of technical uses, they were not capable of retaining silver fluoride in a state of fusion. Numerous vessels were also made of seventeen different fluorides by moulding them in the state of clay and baking them at suitable temperatures; these also were found incapable of holding melted fluoride of silver. Argentic fluoride was only superficially decomposed by chlorine at 60° F. during thirty-eight days. When heated to 230° F. during fifteen days in a platinum vessel in chlorine, it was very little decomposed. Chloride of silver heated to fusion in a platinum vessel in chlorine corroded the vessel and formed a platinum-salt, as when fluoride of silver was employed.

An aqueous solution of argentic fluoride agitated with chlorine evolved heat and set free oxygen, in accordance with the following equation:—

$$8AgF+8Cl+H_2O=5AgCl+3AgClO+8HF+O,$$

or—

$$7AgCl+AgClO_3+8HF+O.$$

Dry hydrochloric acid gas completely decomposed argentic fluoride in a melted state, but only acted upon it superficially at 60° F. A saturated aqueous solution of argentine fluoride was not precipitated by chloric acid.

Perfectly anhydrous fluoride of silver was only superficially decomposed by contact with bromine in a platinum vessel during thirty-six days at 60° F., or during two days at 200° F. At a low red heat, in vessels of platinum, argentic fluoride was completely decomposed by a current of bromine vapour, a portion of its fluorine being expelled and a portion corroding the platinum and forming an insoluble compound of fluoride of platinum and bromide of silver. In carbon boats at the same temperature the whole of the silver-salt was converted into bromide, the boat being corroded and the fluoride escaping in chemical union with the carbon. The action of bromine on an aqueous solution of argentic fluoride was similar to the action of chlorine. A solution of argentine fluoride yielded copious precipitates both with hydrobromic and bromic acids.

Under the influence of a temperature of 200° to 600° F. in closed platinum vessels, iodine very slowly and incompletely decomposes argentic fluoride without corroding the vessels, and produces a feeble compound of argentic iodide, fluorine, and iodine, from which the two latter substances are expelled at a red heat. At a red heat in platinum vessels, iodine produces argentic iodide, and in the presence of free argentic fluoride corrodes the vessels in consequence of formation of platinic fluoride; iodine and fluorine pass away together during the reaction. In vessels of carbon at the same temperature argentic iodide is formed, the vessels are corroded, and a gaseous compound of fluorine and carbon is produced. By treating an aqueous solution of argentic fluoride with iodine, similar results are produced as with bromine and chlorine; a similar solution yields copious precipitates both with hydriodic and iodic acids.

A mode of analysis of iodine is also fully described in the paper. A known weight of iodine was dissolved in absolute alcohol, a strong solution of argentic nitrate of known strength added to it in portions at a time, with stirring until the colour of iodine exactly disappeared. The mixture was evaporated, the free nitric acid expelled by careful heat, and the residue weighed. The residue was then heated to fusion, to convert the iodate of silver into iodide, and again weighed. Two experiments of this kind yielded accurate results, and the process was easy and expeditious.

* Abstract of a paper read before the Royal Society.

ON SOME SOURCES OF ERROR IN VOLUMETRIC ANALYSIS.*

By ROBERT R. TATLOCK, F.R.S.E., F.C.S.

THE object of this note is to point out a few of the many sources of error in volumetric analysis, and to indicate the best means of avoiding them. The accurate and observant experimenter will find little that is new in what I have to bring forward, but at the same time I intend to refer mainly to such circumstances as are but too frequently overlooked by the ordinary analyst.

In the first place, I would seek to direct attention to a source of error which, so far as I can ascertain, has hitherto been overlooked by chemists. It arises from the fact that saline solutions contract, as a rule, when mixed with water, the extent of the decrease in volume depending on the nature of the saline substance dissolved, as well as on the strength of the solution. This fact, although it does not seem to have been recognised in principle till within a comparatively recent period, appears to have been discerned in practice for a very long time back, as otherwise there would have been no necessity for the elaborate tables showing the proportions of salts, of acids, and of alkalies in solutions of different densities, with which many chemical works, even of old date, are amply provided. Much misapprehension prevails, even at the present time, regarding the nature of solution, but more particularly in connection with its effect on volume. In the CHEMICAL NEWS of July 15th, 1870, we find a paper by S. Beswick, of Boston, U.S., calling attention to the circumstance that Swedenborg was the first to announce that when saline substances were dissolved in water there was *no increase in bulk*, the volume of the solution being exactly the same as that of the water employed, a doctrine which was afterwards promulgated by Dalton. The author of that paper seems to take the doctrine for granted, and claims for Swedenborg the honour or credit of the discovery. A very superficial glance, however, will show that the hypothesis is altogether a mistake, for, if it were true, the density or sp. gr. of a saline solution would at once indicate the proportion of solid matter it contained, which we know is very far from being the case, On the contrary, it has been shown by Persoz that the volume of a saturated saline solution is just the volume of the water plus the volume of the salt. It is also certain that, when the saturated solution is mixed with water, a reduction in volume takes place. The sum of the volumes of the saline fluid and the water being appreciably more than that of the product after diffusion has occurred. This fact may be made apparent in various ways. For

* Abstract of a paper read to the Chemical Section of the Glasgow Philosophical Society, on Monday evening, Dec. 19.

example, if we mix together equal volumes of a salt solution of any given gravity and of water, and test the gravity of the resulting mixture, we find it higher than that of the mean, which of itself demonstrates that contraction has taken place, and we have thus a most refined method of determining the *amount* of condensation by accurately taking the gravities of the solutions at different strengths. The actual shrinking may be seen by half filling a large bulb of known capacity, provided with a long, narrow graduated stem, with saturated solution of common salt, and carefully filling completely to one of the marks on the narrow neck with water, taking care that the liquids do not diffuse. The level of the water having been accurately observed, by swaying the flask to and fro for some time, in order to mix the two liquids, the fluid is seen to run down the stem to such an extent that, with a bulb capable of holding one litre, and having a stem of one centimetre internal diameter, a difference of level of from ten to fifteen centimetres may be observed. Nor is this diminution in volume due to the slight reduction in temperature which is usually observed to accompany the diffusion, as that is generally too small to account for any appreciable alteration in volume.

I have made very many trials of various saline solutions in this direct way, but the following example, that of sulphate of ammonia, which is selected on account of its giving unusually marked results, will serve to give some idea of the extent of these contractions:—

Vol. of sulph. amm. sol. used.	Vol. of water used.	Sp. gr. of sulph. amm. sol.	Solid matter, per cent, by weight.	Solid matter, per cent, by vol.	Contraction, per cent, of total vol.
1	1	1·2500	43·5	54·3	1·165
1	1	1·1394	24·5	27·9	0·361
1	1	1·0756	13·5	14·5	0·115
3	1	1·2500	43·5	54·3	0·787

The diminution in bulk which takes place when various fluids are diffused in water is well known.

The practical distiller, in making down a high strength of spirit to a lower, expects to find a smaller volume of product than that of the sum of the two fluids used. It is also quite understood that strong sulphuric acid when mixed with water gives contraction, but I was not prepared for the result of some experiments, which showed an immense contraction even while the fluid remained at 100° C.

Only fifteen years ago Michel and Krafft denied that any diminution in volume takes place when saline solutions are mixed with water. How they could come to that conclusion in the face of the fact that a mixture of given bulks of saline solution and of water is not a fluid whose density is the mean of the two, it is difficult to conceive. Later experiments by Kremers, Schiff, and Persoz, show that contraction takes place as a rule, and Schiff mentions the curious circumstance of non-contraction in the case of ammonium chloride. More minute experiments are required, however, before the latter exception can be considered established.

The circumstances attendant upon these effects are very complicated, and in the present state of science the results cannot altogether be explained. In the case of saline substances the shrinking is usually accompanied by a slight reduction in temperature, whereas we naturally expect an elevation, as in the examples of alcohol and of sulphuric acid. According to observations by John Tatlock, sugar solutions and glycerine solutions contract and give heat on diffusion with water.

What the analytical chemist has chiefly to do with, however, is the effect of these contractions on the accuracy of his results when that has to depend to any extent upon the solution of a salt and the accurate division of the solution. In the ordinary analysis of a mixture of saline substances, such as a commercial potash salt, the method usually, and very properly, followed, is to dissolve the substance in water and filter into a measuring flask. The filter having been washed till the flask is half full or more, the solution is made up, accurately, to the mark with water, and is then thoroughly mixed. It is obvious that contraction must here take place, and that if we do not take this into account, we shall, when we proceed to divide the solution by pipettes, actually draw off a somewhat stronger solution than if no contraction had occurred. It is hardly necessary to observe that this error may to a great extent be obviated (1) by using as weak solutions as possible, as it is manifest from the example given that strong solutions contract far more for a given weight of solid substance than weak ones, and (2) by mixing the saline solution thoroughly with the water before making quite up to the required bulk.

Another source of error, and one I believe not often taken into account, arises from the fact that graduated vessels made to *deliver* fixed volumes of water do not deliver exactly corresponding volumes of saline fluids. Hence we do not obtain the exact amount of solid substance which we expect if we base upon the water-delivering capacity of the pipette or other vessel.

The following tabulated statement of the results of a few trials with solutions of common substances, will show that the adhesion of a strong solution to the glass surface is very great, and quite sufficient to disturb the accuracy of results in most ordinary cases.

The vessel used was a pipette, which delivered 1000 grs. of water at 60° F., by draining for ten seconds, and then touching the delivered water twice with the extreme point:—

Solution used.	Sp. gr.	Solid matter, per cent, by weight.	Pipette used. Vol. grs.	Weight of solution delivered.
Sulphate of ammonia	1·2500	43·5	1000	1247·4
Chloride of potassium	1·1812	24·5	1000	1179·3
Chloride of sodium ..	1·2072	26·4	1000	1204·4
Sulphate of zinc ..	1·4264	53·0	1000	1419·6
Chloride of ammonium	1·0724	26·0	1000	1071·9

It is obvious from these results that a pipette, delivering 1000 grs. of water, does not, as we should expect, deliver a quantity of fluid corresponding with the sp. gr., but sensibly less, and hence a pipette must be graduated to deliver, not water, but the particular saline solution to be employed; that is, the volume of the fluid delivered must be such that the weight will be identical with the gravity. As in the error caused by diffusion—contraction—the difference is here much greater in strong solutions, for a given weight of solid salt, than in weak ones, but a reference to the above example of chloride of ammonium will show that the difference depends upon the sp. gr. of the solution rather than on the amount of solid matter which it contains. Weak solutions are therefore to be preferred in all cases.

Another source of error, but one more generally recognised, arises from the fact that saline solutions expand more than water for equal increments of heat, and, as a necessary consequence, contract more than water by reduction of temperature. The expansion increases very rapidly with the strength of the solution, so that we should either work as near to the standard temperature as possible, or, where that is not admissible, with weak liquors.

The author next referred to the defects of graduated vessels as usually sold, and exhibited and described an apparatus devised by Mr. James Chalmers, of Iquique, Peru, by which a tube, although of unequal calibre throughout, could be graduated, so that each division delivered exactly equal volumes of the same fluid.

NOTES ON THE PROGRESS OF FOREIGN ANALYSIS.*

By Dr. LUNGE.

MOHR (vol. viii., p. 13) proposes to protect solutions of bichloride of tin, sulphuretted hydrogen, caustic baryta, sulphurous acid, and the like, against the action of atmospheric oxygen and carbonic acid, by covering them with a layer of petroleum.

Reichardt (p. 116) recovers uranium oxide from the residues accumulating from estimations of phosphoric acid by dissolving the uranium phosphate in hydrochloric or nitric acid, adding an excess of ferric chloride and sodium acetate, diluting and boiling for some time. The phosphoric acid is completely precipitated along with basic acetate of iron, and all uranium remains in solution. A cheaper method is to precipitate the acid solution of uranium phosphate after adding an excess of ferric chloride with sodium carbonate. The excess of the precipitant retains the uranium oxide completely in solution; the filtered solution is acidified with hydrochloric acid, heated till all carbonic acid is driven off, and the uranium oxide precipitated by ammonia.

Kubel (p. 125) draws attention to the fact that the precipitate caused by ammoniacal solution of magnesia in the solution of a phosphate contains more magnesia than corresponds to the calculated formula, and that this precipitate must therefore be re-dissolved and re-precipitated to obtain accurate results.

Cossa (p. 145) gives the results of careful experiments upon the solubility of calcium carbonate, dolomite, &c., in water saturated with carbonic acid.

P. 174, Bunsen's paper on his filter pump.

Gerlach (p. 245 to 298) gives a number of exceedingly valuable tables of solubility, embracing, perhaps, all published determinations of this character in a synoptic form. This part can be purchased in a special reprint.

Trommsdorff (pp. 330 to 370) gives a complete course of instructions for water analysis, which also deserves to be published separately. There are copious additions to it in vol. ix., pp. 157 to 176.

Schönn (p. 380) describes a method of decomposing many refractory substances by means of sodium or potassium in a steel crucible.

Emmerling (p. 434) describes the action of boiling liquids, water, acids, alkalies, &c., on glass and porcelain vessels. As Fresenius has done before, he finds that hydrochloric and nitric acid act on glass less than boiling water, but the addition of sulphuric acid, and especially of caustic or carbonated alkalies, acts in the opposite way. He, therefore, strongly advises to avoid evaporating solutions ever so slightly alkaline; not to use quite new vessels, which are far more acted upon than when they have been sometime in use; and to diminish the bulk of the washings, which can be easily done by the use of Bunsen's filter pump. Especially he recommends the use of porcelain vessels in preference to glass, wherever practicable, as water and acids have next to no action upon them, and alkalies much less than upon glass.

Böttger (p. 449) recommends test-paper stained with an alcoholic solution of alkanine. The smallest trace of alkalies, especially of ammonia, changes its deep red colour into blue.

Stein (p. 450) describes the way to prepare ultramarine paper for the purpose of testing for free acid in commercial sulphate of alumina, and other salts, which even in the completely neutral state act upon the ordinary test-papers like free acids, but not upon ultramarine, which is only discoloured by really free acid.

Poleck (p. 451) asserts that the formation of carbonic oxide, which has been observed during the action of potassium pyrogallate on oxygen, or mixtures containing it, and which has been believed to render this analytical method useless, takes place only when the proportion of oxygen in the mixture is greater than in atmospheric air. In the latter, or in mixtures containing less oxygen, no carbonic oxide at all is formed by this method.

Löwe (vol. ix., p. 20) proposes to substitute for the usual test solution of alkaline copper tartrate, another alkaline solution of copper, produced by the help of glycerine. It can be made more quickly, does not incline to the formation of fungi, and is much more stable, even in diffused daylight. To a solution of 16 grammes pure crystallised copper sulphate in 64 grammes water, there is added in the cold 80 cc. caustic soda solution of 1·34 specific gravity, and the mixture is shaken up with 6 to 8 grammes pure glycerine till all is dissolved. If this solution shows the least turbidity on diluting with two-thirds of its bulk of water, or on heating, a little more caustic soda and glycerine must be added. If it is desirable to have a solution free from sulphates, freshly precipitated copper hydrate is dissolved in soda solution, with the help of glycerine.

Reinige (p. 39) describes a very interesting method for the estimation of iodine, viz., by means of potassium permanganate. Two equivalents of the latter, and one equivalent of potassium iodide, produce one of potassium iodate, two of free potassa, and four of manganese peroxide. The decomposition is assisted by boiling the solution, and if the latter is very dilute, a little potassium carbonate is added to induce the commencement of the reaction. As bromine and chlorine are not in the least acted upon under the same circumstances, this reaction is, perhaps, the most convenient for the estimation of iodine. The latter must be combined with potassium, and the solution rendered nearly neutral but still slightly alkaline. It is heated till it boils gently, and a solution of 2·5 grammes potassium permanganate in 497·5 grammes water is gradually added, removing the beaker from the lamp each time for a few moments, to allow the precipitated peroxide to deposit, but heating it again to the boiling-point before adding another portion of permanganate. When the solution, after the precipitate has subsided, shows a distinctly reddish tint, all potassium iodide is decomposed. The small excess of permanganate is estimated by sodium hyposulphite, and the remainder shows exactly two milligrammes of iodine for each cc. of the permanganate solution used. The results are very accurate.

Fresenius (p. 52) describes a number of very important experiments concerning the influence of various acids and salts on the precipitation of barium sulphate, and the admixtures of foreign salts with the precipitate. His conclusions are:—(1). Barium sulphate does not require 43,000 parts of water for solution as usually stated, but upwards of 400,000 parts, even in presence of hydrochloric acid, which slightly raises its solubility. (2). Sodium chloride, potassium chloride, and barium nitrate do not increase its solubility very perceptibly, but the alkaline nitrates do so. (3). Hydrochloric acid does the same, and it must, therefore, be evaporated or partially neutralised before the precipitation. (4). Sodium chloride does not produce any foreign admixture in the precipitate. (5). Potassium chlorate does cause such admixture in a high degree. The precipitate can, however, be purified by digesting with hot hydrochloric acid, evaporating the same, and washing with water. (6). Sodium, potassium, and barium nitrate cause a very impure precipitate, which cannot be purified by washing with hydrochloric acid, but only by fusion with sodium carbonate, and estimating the sulphates in the aqueous solution of the fused mass.

Schorer (p. 213) describes and figures an extremely simple thermostat. The principle is, that the air in an empty test-tube inside the air-bath acts by its expansion or contraction on the mercury in one leg of a U-tube, into the other leg of which the gas delivery tube dips. The latter has a long narrow slit, which is lengthened or

* From *Fresenius's Zeitschrift*. Read before the Newcastle-upon-Tyne Chemical Society.

shortened as the mercury falls or rises, and thereby increases or decreases the quantity of gas delivered. A set screw on the top allows of adjusting the dip for any temperature required.

Lowe (p. 216) gives some excellent hints on the ultimate analysis of organic bodies.

Bunsen (p. 283) describes his method of analysing the ashes left by the combustion of vegetable or animal bodies. It is precisely the same as he has taught for many years past to those working in his laboratory.

In the discussion which ensued,

Mr. R. C. Clapham said, with reference to Emmerling's paper, that the glass floats and windows in vitriol chambers were very often much corroded, and that this effect, which he attributed to hydrofluoric acid, varied very much with different kinds of glass.

The President (Mr. John Glover) had seen fluor spar in cargoes of pyrites.

Mr. W. H. Richardson, with regard to Stein's test-paper, said he had never found commercial sulphate of alumina which did not more or less affect ultramarine.

Dr. Wright suggested, as a delicate test for free acid, a mixture obtained by precipitating Prussian blue in the ordinary way, adding slowly weak caustic potash till the colour is just discharged, and diluting.

The President, with regard to Fresenius's paper, drew attention to the great discrepancy between results obtained here and in London from the same samples of pyrites, and promised a communication on this point.

ON THE STEARIC ACID INDUSTRY.*

By J. LAWRENCE SMITH.

Manufacture of Candles.

The name stearine does not represent the true character of the substance (it being stearic acid), but as it is one accepted by the industrial world, it is proper to retain it. This substance, the result of certain chemical processes, is now manufactured in all parts of the world.

The quality of the product does not vary materially. There seems to be rather a greater range in the qualities manufactured in some countries than in those manufactured in others. In France the demand for quality appears more uniform than in England, for in England a large number of softer candles are in general use, while the universal demand in France is for a hard, white, smooth candle. The principal difference noticed in candle stuffs at the Exposition is that some are a little more mottled than others. This is attributable in part to the difference of the methods of saponification—that made by the sulphuric acid saponification being more mottled than when treated by lime; but my observation convinces me that this defect is principally due to the method and care in cooling the melted stearine before moulding. In the character of the stearine products, there is no advance on the Exposition in London in 1862, this being due to the fact that there was hardly anything left to be desired under this head.

If we are enabled to make such beautiful candles out of almost any description of fatty matter, it is entirely due to the application of some of the most interesting chemical results on record; and it is with just pride that France can claim the development of the whole subject from its incipiency to the present perfection of the industrial processes. These labours commenced with M. Braconnot, of Nancy, in separating oleine and stearine, and were extended through the remarkable scientific researches of M. Chevreul. That these labours deserve to be ranked so high, arises from the fact that they were made at the birth of organic chemistry and on a most difficult class of bodies about the nature of which there was no correct conception and when the analyses of organic substances had been but just commenced. Still more, M. Chevreul did not give to the world the results of his labours as a mass of isolated facts, but he systematised and classified new acids, new bases, and left to us the chemical history of facts almost as fully made out as they are at the present time; and these have contributed as much, if not more, than any class of researches to give direction and growth to organic chemistry. The decomposition of the fats and formation of the fatty acids developed the fact that, when melted and allowed to cool slowly, the more solid acids crystallised out of the mixed mass in such manner as to allow of easy separation of the solid from the liquid part, which fact soon suggested a practical application. Without, however, going into details of all the known processes, so fully and clearly described by M. Stas in the report of the Exposition of 1855, a tolerably comprehensive review of the subject will be given.

In 1823 a complete account of the labours of Chevreul was published; at this period fruitless efforts were made to manufacture stearine, but without success. It was in 1831 that Adolph de Milly overcame the practical difficulties of manufacturing stearine on a large scale, and established this branch of industry on certain principles, some of which have remained unaltered, while others have been materially changed in later years by the same chemist, as will be seen a little further on.

The first countries in which stearine candles were manufactured were France, England, Belgium, Russia, Austria, and Sweden. This manufacture gradually found its way into other parts of the world, and it is now carried on in the remotest places, as Calcutta and Sydney (Australia).

Importance of the Stearic Acid Industry.

It is difficult to render an exact account of the importance of the stearic acid industry; nevertheless it can be stated with certainty that the annual production for France is 25,000,000 of kilos., and approximately for the remainder of Europe is 100,000,000 of kilos., and for America 10,000,000 of kilos.

The largest candle factory in the world is that known as the Price Company, having its principal establishments at Liverpool and London. Its principal products are what are called the composition candles, of a good quality, but a little greasy to the touch. These candles are used in England by all classes, but would not be received in other countries, where the requirements of luxury are more exacting. The establishments in Holland and Belgium are relatively of great importance, arising from the fact that apparatus, coal, and labour are cheap; the consequence being that these candles are manufactured cheaply and sold at corresponding prices, and are enabled to be exported more than they are used. As previously stated, from 1831 to 1846, saponification in open vessels by lime was altogether employed; in 1846 another process was introduced, viz., saponification by sulphuric acid followed by distillation. These two processes had their advantages and disadvantages. The saponification by lime gave a small relative yield of candle stuff, but the candles were of the finest quality, having a high melting-point; the yield of oleic acid was greater and of a superior quality. On the contrary, the sulphuric acid followed by distillation yielded a larger amount of candle stuff, but of second quality, and a smaller yield of liquid matter of inferior quality. The industrial world employs one or other of these other methods, according to the requirements and circumstances governing the demand and the nature of raw material employed. In some countries smooth, white, dry candles, of a light melting-point and of the first quality, are required, while in other countries, attracted by the low price, a candle is used that is yellowish, soft, and greasy to the touch, with a low fusing-point. For this reason, France, Germany, Russia, Italy, Spain, and Portugal,

* From "The Progress and Condition of Several Departments of Industrial Chemistry," by J. Lawrence Smith.

still employ the lime saponification, and Belgium, Holland, England, and America adopt the sulphuric acid to a great extent. As regards the profits of the two methods they are about balanced, because one class of manufacturers sell at a higher price for products of a better quality but smaller yield, while the other class sell an article at a lower price but of an inferior quality. But it is an observed fact that those who manufacture by sulphuric acid and distillation do not meet with the same commercial success as those manufacturing by lime.

There were forty or fifty factories that exposed products arising from the treatment of fats. Of these about thirty were French. Nineteen of these employed the old lime saponifiation with fourteen per cent of lime; three by the closed autoclave under pressure, with a diminished quantity of lime; one by the sulphuric acid saponification; two by water decomposition under pressure; and five by different methods of distillation. The more modern method of saponifying under pressure is gradually coming into use, and Messrs. Perré and Son, of Elbeuf, exhibited beautiful products made by that process with the apparatus invented by Renner.

Account of the Stearine Industry.

The first persons who thought of applying the fatty acids for the purposes of illumination were Gay-Lussac and Chevreul. For this purpose they took out a patent in January, 1825, which patent specified "that they reserved to themselves the exclusive right of preparing fatty acids for illumination, both liquid and solid, such as are obtained by saponification of the fats with *potash, soda, and the other bases, by the acids or by any other means.*

"We saponify the fats either at the ordinary boiling point with the pressure of a single atmosphere, or at a more elevated temperature with the pressure of several atmospheres. We have recognised that the saponification conducted in this way has great advantages over that conducted in the ordinary way under a single atmospheric pressure, 'the saponification being accomplished with the smallest possible quantity of alkali. We separate the stearic and margaric acid from oleic acid by the following processes.'"

This is done by several processes detailed in the patent, but the one essentially practical is by decomposing the soap with acids, and, by pressure, separating the solid from the liquid acids. It will be seen that this process is deduced directly from the theoretical researches of Chevreul, with the important exception in relation to saponifying under high pressure.

The process of Chevreul and Gay Lussac was not considered at the time capable of being brought into practice in the arts, from their using potash and soda, thus making the product a very expensive one.

Besides the above difficulty in the original development of stearic industry, another arose in the very commencement, viz., that when candles were made with the ordinary wick they burnt very imperfectly, and the inventors above referred to devised wicks of peculiar description that answered the purpose more or less perfectly. But prior to them, J. L. Cambacérés, devised similar ones, and subsequently improved upon them, and finally settled upon the plaited wick now in common use in all stearic acid factories.

The next important step in rendering the stearic acid industry a success was also made by M. Cambacérés, viz., the separation of the oleic acid by powerful pressure, first on the mixed acids cold, and subsequently warmed; and he established a factory in Paris to carry out his process, but this soon failed, from the inferior nature of candle-stock produced and the expense of its production, potash being employed by him as the agent for decomposing the fats.

For several years this industry was abandoned as being a difficult and unprofitable one, when, in 1829, two young physicians, De Milly and Motard, took the subject up, and, after two years of laborious and persistent study of it, accomplished the problem of the successful manufacture of candles from the fatty acids. It is only simple justice to say that the names of Chevreul and De Milly go side by side in this industry, the first in his theoretical discoveries, and the latter in his ingenious and successful devices in the accomplishment of great practical results. Nor is it too much to rank De Milly nearly as high as Leblanc for endowing chemical industry with an art so thoroughly perfected by him and leading to such important economical results in the every-day wants of the civilised world. France may well be proud of having given to the world the art of making soda by Leblanc, and that of making stearic acid candles by De Milly.

The success in making these candles depended first on the discovery of an economical means of saponification. This means consisted in the employment of lime to replace potash or soda, which method had been indicated in the original patent of Gay-Lussac, but no one had solved the problem successfully until it was done by MM. De Milly and Motard, in 1831, in a factory established by them near the *Barriere de l'Etoile* at Paris, and it is from the locality of this first factory that the almost universal name of "star candles" has been derived.

In the original method of saponifying by lime, De Milly and Motard conducted the operation in a closed vessel, under pressure, but from the difficulty of proper manipulation during the operation, it was abandoned, and afterwards carried on in an open vessel at the temperature of 100° C. We do not intend to go into any detail as regards the process already so well-known and described in works on technical chemistry, but simply to give a rapid sketch of its history and development.

The De Milly and Motard Process of Saponification.

After the lime soap is formed, it is decomposed by sulphuric acid, and the resulting fatty acids are cooled in shallow tin or copper pans, in rooms of about 60° F., so as to allow of the proper crystallisation of the solid acids. The next step is to press these acid cakes, which is first done in a cold press, then in a hot press, first suggested by Cambacérés, but successfully carried out by the horizontal presses invented by De Milly and Motard, and now universally employed in candle factories.

The difficulties, however, of these indefatigable manufacturers were far from being overcome; the pans coloured the fats with iron, the last trace of lime was not removed, and the candle made had a crystalline structure. By the alternate application of steam and dilute sulphuric acid, and white of egg and oxalic acid, they overcame the first difficulty. Various means were tried to prevent the crystalline structure, commencing with the objectionable use of arsenious acid, then the more expensive one of wax, which also had a tendency to colour the candle; they at last triumphed over this difficulty by cooling the acids to a temperature near their point of solidification before introducing them into the moulds that were first raised to the temperature of the cooling fats. During the cooling of the mass it is constantly agitated, and a pasty liquid is produced, which congeals in the moulds without crystallisation. Three years had now elapsed since the first establishment of their factory, the commercial results of which had been a failure. M. De Milly now came into the possession of the factory alone, his faith in its success remaining firm, and two years later, in June, 1836, he gave the perfecting touch to the successful manufacture of star candles. The wick has always been a source of great annoyance in the burning of the candles, for the small amount of mineral matter in the candle stuff would accumulate in the wick, and interfere with the free flowing of the melted fat. After numerous trials by saturating the wick with different substances, the required result was successfully accomplished by impregnating the wick with a certain quantity of boracic acid, dissolved in water containing one-thousandth of its weight of sulphuric acid. The boracic acid, as the combustion of the

candle progressed, united with the lime and the ashes of the wick, forming a very fusible salt, which accumulated on the end of the wick, forming a small drop.

With this last application in 1836 is to be dated the complete success of the stearic acid industry. The civilised world recognised it as such, and factories sprang into existence in various parts of Europe and America. Since then there have been some minor perfections in the above process, known as the lime saponification process. There have been, however, other processes put in practice for bringing about the same results that will be passed in review, viz :—

(1). Saponification by sulphuric acid and subsequent distillation.

(2). Saponification by water combined with distillation of glycerine and fatty acids.

(3). Saponification by water under pressure.

(4). Saponification by water under pressure with a very minute quantity of lime.

(5). Saponification by sulphuric acid without subsequent distillation.

ON THE EXAMINATION OF THE BARK OF COPROSMA GRANDIFOLIA, FOR ALKALOIDS.

By W. SKEY,
Analyst to the Geological Survey of New ealand.

The sample I tested was named by Mr. Buchanan, at the time of collecting; it has a bright yellow colour on its inner surface, is very bitter, with a slightly hot pungent flavour. It is decidedly the bitterest of any of the barks of this family which were pointed out to me, and for this reason I made choice of it for experiment.

The following is a brief summary of the results obtained :—It shows by an easy, simple, and I think a reliable process, that alkaloids, generally, and those of the Quina group in particular, are either entirely absent, or present only in so minute a quantity that the bark is quite worthless as a drug, on this account at least.

A decoction of 200 grammes of the pulverised bark, in weak hydrochloric acid, was slowly evaporated to a bulk of half-an-ounce, then filtered; the filtrate did not give any precipitate with the following reagents :—

Sulphocyanide of mercury.
Sulphocyanide of zinc.
Tannic acid.

These substances are capital tests for the alkaloids generally, giving dense precipitates in a very weak decoction, even of the common Gray bark.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from p. 11.)

One of the most important observations was made, at an early stage of the investigations, on the subject of ferments, by Dr. Schwann. He passed air through a red-hot tube, and he asserted, as the result of his operations, that air which had been so heated was incapable of producing the effects, which I mentioned just now as having been noticed by other observers, as produced by common air; that, whereas ordinary air starts fermentation, air which has been passed through a red-hot tube does not. That was what he said, and in some of his observations he was quite correct, but in some others he must have been misled. Shortly after his observations, another German philosopher thought of using cotton-wool as a strainer. He passed air through a glass tube fitted up somewhat in the same manner as the one I have here, with a tolerably compact plug of cotton-wool, which allowed the air to pass through it, but at the same time acted as a strainer, and collected a quantity of dirt at the side where the air entered it; and he found that the air which had been thus strained was no longer capable of producing the phenomena of decomposition, which air in the unstrained or unheated state does. Since, then, Pasteur has done the same thing in a more accurate and more decisive manner; and he has repeated the experiment with heated air, with precautions which leave nothing to be desired. One novelty in Pasteur's process is the use of a kind of cotton which is soluble—cotton which has been in contact with strong nitric acid, which is called gun-cotton. It retains the structure and appearance of ordinary cotton, but has this peculiarity, that it dissolves easily in a mixture of alcohol and ether. He put into a tube a plug of this gun-cotton, and then, by means of an aspirator, he drew air through this strainer for a long time, until he had collected quite a quantity of dust. He then took this gun-cotton with the dust upon it, and put it into a tube, where he poured alcohol and ether upon it, until the cotton was dissolved, and nothing left but the dust. In that manner he got the lightest portions of the dust and the heavier portions by themselves, as they very soon subsided in the liquid in which the gun-cotton had been dissolved. He then poured fresh alcohol upon them, so as to thoroughly cleanse them, and then put them under the microscope, in order to examine the particles of which they consisted. He found in this dust a great many particles of sand, calcic carbonate, and other mineral particles, as would naturally be expected, and also a great quantity of organic matter—little particles of cotton, wool, wood, and so on, and mixed with these he found some little spherical or oblong particles of very different sizes, and of some considerable varieties of shape. Some of these little round particles he found consisted of mere starch, and many of you are, no doubt, aware that starch consists of little spheroidal masses of different sizes. These he got rid of by a solvent, and others were then left, which resembled in their appearance so closely the germs of various fungi and organisms of those kinds and eggs of animalcules, that they were, to outward appearance, undistinguishable from them. He then took a liquid which had been boiled, but which was capable of decomposing—such a one as I mentioned here—by the action of any of these substances, and he put it into a flask, with precautions which I will not detain you by mentioning now more than to say that he slid into this liquid, which had not got anything present to induce the formation of organisms, some of the gun-cotton with the dust yet in it. It was the same thing as I mentioned before, only that the substance had got some of this dust from the air added to it; and he found that he also got the formation of organisms very readily and abundantly. He found that these little particles, which were to the eye undistinguishable from germs and spore, behave towards liquids of this kind just as if they were so. In various other ways the same form of experiment has been repeated, and uniformly with the same result, viz., that when little particles collected from the air, particles of extreme tenuity, are put into a liquid susceptible of undergoing decomposition, a great variety of organisms will make their appearance, just as if their seed had been sown in the liquid. This circumstance is one which, I think, will justify us in going back to what I told you of Pasteur's previous observations. I told you that he opened a number of the little bulbs which had contained yeast-water and sugar, so as to allow the air to rush into them. He found that, in some cases, he got one kind of organism produced, and in others another; in fact, he got a great variety. But if, instead of allowing the air to go into these bulbs in this way, he poured the liquid out into an open vessel, he always got the same sort of organisms;

* The Cantor Lectures. Delivered before the Society of Arts.

there was no variety. The appearance of the particles which resembled germs is, as I said, exceedingly various, and there are many reasons to suppose that if there are the germs of the organisms in the air, there must be an immense variety of them, a variety so great that we could not even venture to guess at its extent at present. When the liquid had free access to all of them, it is found, for reasons which would easily suggest themselves, on reflection, to anybody, that some of them, those which can thrive best upon the particular substance, develop themselves to the exclusion of the rest. I will give you one or two examples of the influence of food upon the development of ferments, instances which are well known, and are of some importance, as serving to prove the point which I have just mentioned. You are aware that the mixture which I have been speaking of, yeast-water with sugar, can be made to undergo alcoholic fermentation. I have already referred to it repeatedly in that point of view. We can make it undergo alcoholic fermentation if we put some alcoholic ferment into it, and keep it at a proper temperature; but if, instead of putting some number of cells—and even a few grains weight consist of an enormous number of cells—if, instead of that, we were merely to leave some of this liquid in contact with the air, we should have no alcoholic fermentation set up in it. That particular mixture of yeast-water and sugar does not, when exposed to all these germs, get yeast-cells developed in it, at all events, not to any perceptible extent. Instead of that, it gets cells formed which are similar to those in the second bottle I showed you, which is forming lactic acid; that is to say, the lactic fermentation will set in. The fact is, that the liquid is unwholesome for these particular cells, and does not agree with the alcohol cells, or yeast cells, so that if a great number of various germs are thrown into these particular substances, those which can thrive better, which are the lactic acid cells, develop themselves, and the alcohol cells do not. Again, if instead of taking this decoction of yeast and sugar, you were to take some grape juice, you would have alcoholic fermentation at once. That is the way it is done. If I were to leave a decoction of malt in contact with the air, in the same manner you would get the same thing set in as a rule. Again, if some of the liquid which I have in the glass dish here—some of the yeast-water with a little alcohol and acetic acid—be left in an open vessel, it gets an organism formed upon it; in fact, that is a process which Pasteur recommends for getting vinegar cells, if you want any. He says the air will, if you give it time, and supply the requisite conditions, start these cells in that mixture, but no alcohol cells, nor lactic acid cells, can be grown in it. It does not suit them; it is a substance which suits vinegar cells, and them only. Whatever may be the variety of the cells present in the air, it only developes those of that particular kind.

(To be continued.)

THE SUCRATE OF THE HYDROCARBONATE OF LIME APPLIED TO THE PURIFICATION OF THE SUGAR-CANE JUICE.

By MM. BOIVIN and LOISEAU.

What the authors call sucrate of hydrocarbonate of lime is a substance containing sugar, lime, and carbonate of lime, and in order to apply this material to the purification of saccharine liquids, a series of operations is required, of which the following is an outline:—

Production of the Lime and Carbonic Acid.—Limestone suitable for being burned is placed in a kiln, and the carbonic acid, evolved on being heated, is withdrawn by a pump; the caustic lime thus obtained constitutes, after having been slaked with the least possible quantity of water, the lime alluded to above.

Preparation of the Sucro-calcareous Solution.—A previously measured quantity of the saccharine liquid, one which it is desired to purify, is intimately mixed with lime so as to obtain the solution of that base; this liquid is next run into a large reservoir, but passes, previous to entering it, a sieve to retain undissolved particles.

Formation of Sucrate of Hydrocarbonate of Lime.—By the partial saturation, by means of carbonic acid, of the lime, contained and kept in solution by the sugar as just stated, the sucrate of hydrocarbonate of lime is obtained. This fluid is next boiled under pressure, next filtered, while the succeeding operations are, first, the withdrawal of the lime by excess of carbonic acid, boiling of the resulting liquid to expel the gas in excess, and cause precipitation of carbonate of lime; another filtration succeeds, after which the liquor (thick syrup) is filtered through animal charcoal, and lastly evaporated in vacuum pans. The deposited carbonate of lime is well-washed to extract any sugar it might contain, and the weak saccharine liquid thus obtained is used for the cleansing of the charcoal filters. The authors claim a great many advantages resulting from the process here briefly described; it is, however, undoubtedly lengthy, and one which, as has been observed, may lead to serious losses of sugar, especially in not thoroughly skilled hands.

ON THE OCCURRENCE OF SUPPOSED NATIVE COPPER.*

By HENRY BOWMAN.

During the months of March, April, and May last, we were burning at Washington a cargo of copper pyrites from the Tharsis mines in Spain. What appeared to be a block of pyrites broke the stone-breaking machine, being itself broken into three pieces. On being examined it showed marks of being much crushed, and turned out to be apparently a piece of native copper. The pieces exhibited weigh 21¼ lbs., but as some smaller fragments may have been lost, the original mass was probably somewhat heavier. The colour varies in different parts from copper-red to almost white with a hackly fracture. The interior is full of cavities about shot size. The outer surface has no adherent matrix whatever. The specific gravity is 8·4. An analysis, for which I am indebted to Mr. Wm. Moody, showed the following composition:—

	Per cent.
Copper	84·80
Iron	5·54
Zinc	trace
Nickel	0·28
Cobalt	0·14
Antimony	0·50
Arsenic	7·10
Sulphur	0·73
Oxygen	0·41
	99·50

The sample for analysis was taken by breaking pieces off at different places, for in three samples the iron varied from 4·8 to 5·4 and 8·1.

With regard to its mode of deposition, I am inclined, without hazarding a positive opinion, to think that it has been reduced "in the dry way."

I am led to this conclusion by the appearances exhibited on the surfaces of fracture, which appear quite compatible with its having been reduced from a molten, but imperfectly fluid mass of heterogeneous composition, and this would appear to agree with the information afforded by analysis. The appearance of its outer surface seems, also, scarcely consistent with its having been reduced by any wet action from a mass of pyrites.

* Read before the Newcastle-upon-Tyne Chemical Society, October 27th, 1870.

I should add, that not hearing of the accident until two days after its occurrence, I have been unable to obtain a very satisfactory history.

In the discussion which ensued the specimen was generally considered as doubtfully authenticated.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, December 27th, 1870.

E. W. Binney, F.R.S., F.G.S., President, in the Chair.

"*Observation of the Eclipse of the Sun, December 22nd, 1870,*" by J. B. Dancer, F.R.A.S.

The eclipse of the sun on Thursday, the 22nd of December, was favourably observed at Ardwick. Although a slight fog prevailed, all the details of the phenomenon were distinct and tolerably well defined. A number of spots were visible on the sun's surface, two of which were of some magnitude. The nuclei of these spots were linked together by maculæ, and surrounded by a penumbra which extended to a considerable distance. Faculæ also were very numerous and distinct. The approximate times of contact taken by a chronometer corrected by the standard clock at the Town Hall were as follows:—

	h.	m.	s.
First contact of the moon's limb with the sun	11	5	49
Contact of moon's limb with nucleus of the first large spot	11	31	36
With the nucleus of the second large spot	11	37	20
Last contact of moon's limb with the sun, Greenwich mean time	1	37	3

The temperature during the progress of the eclipse was taken at intervals by a mercurial thermometer with a black bulb *in vacuo*, exposed to the sun at the height of four feet from the ground.

Time.				Temp.
h.	m.	s.		Degrees.
11	10	0	.. ..	31·50
—	35	0	.. ..	30·25
—	45	0	.. ..	29·75
—	50	0	.. ..	29·25
12	22	0	.. ..	27·20
—	35	0	.. ..	28·50
1	37	0	.. ..	29·00

I had an impression that the moon's edge could be traced a short distance from the edge of the sun at the upper and lower points of contact, but this might be imagination.

The black surface of the moon appeared very uniform in colour. I tried with powers of 80 and 180 to distinguish the moon's disc, but did not succeed. Light clouds were passing over the sun's disc at this time. The diminution in light was quite perceptible at the time of the greatest phase.

Mr. Baxendell said that he observed the commencement of the eclipse at Cheetham Hill. The first contact took place at 11h. 5m. 46·2s. Greenwich mean time, or 24·2 seconds later than the time calculated by Mr. Dickinson and Mr. Hind. The definition of the limbs of the sun and moon, and of the spots on the solar disc was remarkably good, and he did not think his observation of the time of first contact could be in error to the extent of one second. The limb of the moon on the sun's disc appeared to be more sharply defined than the sun's limb. No distortion of the cusps was noticed. Unfortunately he was obliged to leave the observatory before the end of the eclipse, and therefore did not observe the time of last contact.

CORRESPONDENCE.

CHLORALUM.

To the Editor of the Chemical News.

Sir,—Permit me to protest in the most emphatic manner against Dr. Crace Calvert's system of experimenting on the comparative energy of antiseptics, and the conclusions published under his name in your journal. His tables prove that agents which are not antiseptics do not prevent putrefaction, and that antiseptics must be used in such a manner as to produce their effect or they are valueless. Dr. Calvert might have spared himself the trouble of placing "a known quantity" of chloralum beneath sound meat suspended by a thread in a wide-mouthed pint bottle. The chloride of aluminium is not volatile; nevertheless I have shown how, with a steam vapouriser, it is valuable in purifying the air, and may, under proper conditions, prevent taint in organic matters suspended in such air.

Dr. Calvert has not mentioned sulphurous acid, and yet I have for years kept whole carcasses of mutton and large joints and quarters of meat fresh for periods varying from one to nine months, after having suspended them for a few days in chambers through the atmosphere of which from one to three per cent of sulphurous acid had been diffused. Solutions of chloralum from 1005 to 1010 sp. gr., *i.e.* containing from 1 to 3 parts of chloride to 140 or to 70 parts of water, are sufficiently strong to keep fish and meat which have been simply dipped in them and then suspended in the dry air. The quantity of antiseptic used is but a small fraction of one per cent, and the preservation complete if the necessary precautions have been taken. According to my observations chloralum is more active than sulphurous acid.

Both sulphurous acid and chloralum are available when the carbolic and cresylic acids cannot be used owing to their smell, flavour, and causticity. I have employed the last-named agents very largely for several years, and they stand unrivalled for a limited number of medical and economic purposes, but chloralum covers a much larger field of useful applications, and we are not yet acquainted with a tithe of these. Ten years' experience with carbolic acid has proved that as a sick room disinfectant, and even in open alleys and stables, people refuse to use it. Condy's fluid, valuable in its way, has been supposed to act like carbolic acid and to disinfect, physicians prescribing it gladly, in the erroneous belief that it added to its deodorising properties that of destroying disease germs. Its success has been due to its freedom from odour. This is in a measure the secret of the great success attending the introduction of the harmless and odourless chloride of aluminium. The agent had never been thought of in therapeutics until last January, and the proof positive of its unequalled value is the extraordinary rapidity with which medical men have taken it up, and reported on its use in the treatment of wounds, arresting the fœtor of cancer, checking the throat lesions in diphtheria and scarlatina, preventing suppuration, absorbing from the air the odour of fresh paint, in a manner not yet explained, in addition to destroying many fœtid emanations which are simply masked by carbolic acid, and which are offensive, if not even actively poisonous.

We have lately succeeded in obtaining an odourless disinfecting powder of great strength, containing 30 per cent of chloride, which can compete in price with the 15 per cent carbolic acid powder. Its manufacture is delayed until suitable works can be erected, but any of your readers can obtain a small cask by applying direct to the Chloralum Company, and before the summer it is hoped that an adequate supply of this pleasant deodoriser and disinfectant may be available for dust-bins, earth-closets and many other purposes for which carbolic acid

powders or the more commonly used lime chloride cannot be employed.

Lastly—The London Cotton Mills, Limited, have undertaken the manufacture of wools and waddings containing a definite percentage of chloride of aluminium. Cotton wool thus treated is styptic and antiseptic. It may be used as a padding under bed sores, for the absorption of fœtid secretions, and suspended in the air as a filter of atmospheric currents. A curtain containing a layer of this wool, within a light porous covering suspended over the door of a sick chamber will very materially check the dispersion of fever poisons from a sick room into other parts of a house, and as usual with so useful an article, medical-men will devise many other uses for this antiseptic chloralum wool, which have not yet occurred to your obedient servant,

JOHN GAMGEE.

1, Great Winchester Street Buildings, E.C.
London, January 4, 1871.

MAGNETIC POWER OF A BATTERY.

To the Editor of the Chemical News.

SIR,—Allow me a few lines in reference to Mr. Bottomley's letter in your last, in order to prevent any misconception. The problem he proposes is this. Given a certain number of cells, or given a certain area of platinum and zinc to cut up into plates; how shall the cells be arranged, or how shall the area of platinum and zinc be cut up so as to give a maximum of intensity? The answer to this Mr. Bottomley very correctly gives, namely, when the cells or plates are so arranged as to make the internal resistance equal to the external.

The problem I was speaking of was the following:—Given a certain battery arranged in a certain manner—by what external resistance shall we get most work out of it? Now in this case, curiously enough, we can get most *heat* when the external resistance equals the internal, but we do not also get the most magnetic power. And again, in Mr. Bottomley's problem, though he gets most intensity by his arrangement, he does not get most heat. It is the confusing together of the two problems and the two results, as is often done, that I meant to complain of in a former letter.—I am, &c.,

H. HIGHTON.

Putney, December 24, 1870.

MISCELLANEOUS.

Royal Institution of Great Britain.—The following are the probable arrangements for the Friday Evening Meetings before Easter, 1871, to which Members and their friends only are admitted:—Friday, Jan. 20th. Professor Tyndall, LL.D., F.R.S., M.R.I. Jan. 27th. Professor Odling, F.R.S. Feb. 3rd. W. Spottiswoode, Treas. R.S. and R.I., "Some Experiments on Successive Polarisation of Light made by Sir C. Wheatstone." Feb. 10th. E. J. Reed, C.B., "On Some Fallacies connected with Ships and Guns." Feb. 17. James N. Douglass, Engineer to the Trinity House, "On the Wolf-Rock Lighthouse." Feb. 24th. Dr. W. B. Carpenter, F.R.S., &c. "The Latest Scientific Researches in the Mediterranean and Straits of Gibraltar." March 3rd. Captain Noble, F.R.S., "On the Pressure of Fired Gunpowder." March 10th. W. Mattieu Williams, "On Rumford's Scientific Discoveries." March 17th. J. Norman Lockyer, F.R.S., M.R.I., "On the Eclipse." March 24th. Professor J. Clerk Maxwell, M.A. F.R.S., "On Colour." March 31st. Professsor Max Müller, LL.D., "On Solar Myths."

The Comparative Energy of Disinfectants.—We published last week a note on a series of experiments by Dr. Crace Calvert on this subject. Mr. Bollman Condy writes:—"Among the bodies enumerated was permanganate of potash (Condy's fluid). This circumstance has constrained me to venture to direct your attention to the fact, that that substance is not an antiseptic at all; nor, so far as I am aware, has it been patronised as such by those having an interest in saying most in its favour; at any rate, I can vouch for this being so in my own case. I have always been careful to point out that Condy's fluid is not an antiseptic or preserving agent, but a disinfectant, in the same sense wherein fresh air is one. You will, I think, agree with me that the latter agent namely, air, which is the one whereby ventilation operates as a disinfectant, is no antiseptic. One of the great aims in the preservation of food, for instance, is the exclusion of air. It would, therefore, seem to me that to class the permanganates with antiseptics, and to experiment with them as such, is much the same thing as to class in that category pure air and experiment with it in the apparent expectation that it might prove capable of preserving from decomposition organic bodies. I cannot see that any good would arise from proving that pure air has no antiseptic value; but, on the contrary, believe that only misapprehension as to the value of that essential to health would thereby be engendered in the public mind, which is not yet sufficiently instructed to distinguish between antiseptics and disinfectants. In the same way, experiments undertaken to prove that permanganates are destitute of antiseptic properties, which every one qualified to experiment already knows, instead of being of any service to sanitary science, must, on the contrary, when published, be detrimental thereto, by erroneously leading popular opinion to conclude that they are, therefore, inefficient disinfectants, which is exactly the contrary of the truth. The disinfecting virtues of those agents depend precisely on the same principle as that whereon the efficacy for disinfection of ventilation hangs; namely, the essential element oxygen, which plays the main part in all true sanitation."—*British Medical Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Polytechnisches Journal von Dingler, second number for November 1870.

This number contains the following original papers relating to chemistry and allied sciences:—

Method of Tinning Copper, Brass, and Iron at the Ordinary Temperature, and without the Intervention of any Apparatus.—F. Stolba.—The author states that all objects to be tinned should first be perfectly cleaned from oxide, as well as greasy matter; the cleaning may be effected either by mechanical or chemical means. The ingredients employed are finely-pulverised zinc and a carefully-made solution of protochloride of tin, containing from 5 to 10 per cent of that salt, to which solution about a small pinch of cream of tartar should be added. This solution is rubbed over the object to be tinned, and immediately after some of the finely-pulverised zinc is also rubbed on; a sponge, or a piece of cotton-waste free from grease, is the best for the purpose of rubbing on the solution of tin and the zinc powder. When the tinning is complete, the object is washed with water, and next polished with previously-washed and pulverised chalk.

Iodide of Silver in its Photographico-Chemical Relation.—Dr. J. Schnauss.—We learn from this essay that there exist two modifications of iodide of silver, one of which is actinic—that is to say, sensitive to light—while the other is not so. The author also points out that iodide of silver is very soluble (up to equal equivalents) in a solution of nitrate of silver, forming therewith a double salt, AgO,NO_5+AgI, which, if the solution of the nitrate is quite neutral, is far more sensitive to light than either of the two salts by themselves.

Memoir on the Specific Gravities which Agree with the Degrees of the Areometers in General Use.—Dr. G. Th. Gerlach.—This very valuable paper consists of a lengthy series of tabulated forms showing the number of degrees of the various areometers in general use, and the specific gravities corresponding thereto.

Conversion of Starch into Sugar by the Action of the Diastase of Malt.—Dr. A. Schwarzer.—This essay is not well suited for any useful abstraction, owing to the fact that it contains a series of tabulated forms exhibiting results of experiments. It appears, however, from the author's researches, that—(1) the conversion of starch is quickened by an increased quantity of diastase, as well as a higher temperature; (2) that when starch fails to be detected by iodine, the formation of sugar is nearly finished; (3) at all temperatures from 60° to 0° downwards, and the application of varying quantities of diastase, there are formed always from 50 to 53 per cent of sugar; (4) at temperatures above 60° less sugar is formed than at temperatures below that degree; (5) a temperature of 70° impairs, and in some instances destroys, the activity of diastase.

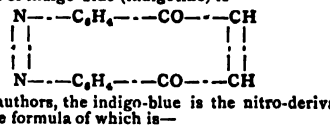
Smoke-Consuming Fire-Place suited for every kind of Fuel.—A. Wagner.—A description of a peculiarly-constructed kind of stove arranged for use either in kitchens or for heating apartments.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 17, 1870.

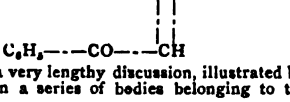
This number contains the following original papers and memoirs:—

Method of Water Analysis.—A. Müller.—The third part of this lengthy memoir, treating on the estimation of sulphuric acid.

Synthesis of Indigo-Blue (Indigotine).—A. Emmerling and C. Engler.—This very exhaustive memoir is divided into the following sections:—On the nitro-derivatives obtained from aceto-phenon (the methyl-keton of benzoic acid, C_8H_8O, obtained by the dry distillation of equal parts of benzoate and acetate of lime, a liquid boiling at 198°). Conversion of mononitro-aceto-phenon (in the state of thick syrup) into indigotine; this process consists in the withdrawal of water, and in a reduction. Constitution of indigo-blue and its derivatives. The structural formula of indigo-blue (indigotine) is—



According to the authors, the indigo-blue is the nitro-derivative of a peculiar keton, the formula of which is—



The memoir contains a very lengthy discussion, illustrated by a great number of formulæ, on a series of bodies belonging to the indigo derivatives.

Chloride of Iodine.—L. Henry.—The author has applied chloride of iodine for the purpose of decomposing some of the oxy-compounds of chlorine. In water kept very cold, and in which some iodine is suspended, a current of chlorine gas is passed until the iodine is dissolved; and to this solution is next added 1 molecule of chlorate of potassa—viz., 122·5 parts for every atom (127 parts) of iodine dissolved. On being next heated, the following reaction takes place, chlorine being evolved:—$KClO_3 + ICl = KIO_3 + ClCl$. On cooling, pure iodate of potassa crystallises from the liquid.

Aromatic Glycolic Acid.—W. Dittmar and A. Kekulé.—This paper treats, first, on the relation existing between a series of aromatic acids, and then on the body discovered by the authors—viz., oxymethyl-phenyl-formic acid—

$$C_6H_4\begin{cases}CH_2.OH\\CO.OH\end{cases}$$

This substance is a solid crystalline body, soluble in hot, and to some extent also in cold water; also in ether; its point of fusion is higher than that of toluylic acid. The oxymethyl-phenyl-formic acid is capable of being sublimed.

Synthesis of Substituted Guanidines.—E. Erlenmeyer.—Hydrochlorate of guanidine may be prepared synthetically by heating an alcoholic solution of chloride of ammonium with cyanamide. When hydrochlorates of aniline, toluidine, and methylamine were caused to act upon cyanamide in the same manner, the author obtained the corresponding hydrochlorates of phenyl, tolyl, and methyl-guanidine. The author's paper is further chiefly devoted to the crystallographical description, illustrated by diagrams, of the platinum double salt of methyl-uramine.

Acids which are formed by the Oxidation of the Fermentation Butyl-Alcohol.—E. Erlenmeyer.—After referring, at great length, to the researches made on this subject, by Dr. Michaelson, in the year 1864, the author states that he found that, among the products of the oxidation of the butyl-alcohol of fermentation, isobutyric acid is present, which, by further oxidation, is readily converted into water and acetic and carbonic acids. This process is illustrated by the following formula:—$C_4H_9O_2 + O_6 = (CO_2)_2 + (H_2O)_2 + C_2H_4O_2$. The author points out that, by means of this process, isobutyric acid may be distinguished from normal butyric acid, which, on being oxidised, yields propyl-butyric acid.

Valerianic Acids of Different Origin.—E. Erlenmeyer.—The chief points of interest in this paper are—Valerianic acid from valerian root is optically inactive and chemically identical with the valerianic acid obtained from inactive amyl alcohol, and from the cyanide of isobutyl, each of which three acids yields with baryta a readily crystallisable salt. The valerianic acid obtained from active amyl-alcohol, and also the acid obtained by the oxidation of leucine from albumen compounds, are optically active, have a somewhat higher specific gravity, a lower boiling-point than the inactive acid, while, moreover, the baryta salt of the former is an amorphous substance. The optically-active acid is converted into an inactive, by applying heat (200°) and a few drops of concentrated sulphuric acid to it.

New York Oxyhydrogen Gas Company.—H. Vogel.—This paper contains a description, illustrated by woodcuts, of the works of the company just named. The process of the manufacture of oxygen, as well as of hydrogen, is that invented by M. Tessié de Mothay. The author, while on a visit to New York, had an opportunity of viewing the works.

Naphthazarine.—C. Liebermann.—This lengthy paper contains the results of the author's researches on the pigment obtained in 1861, by M. Roussin, by heating to 200° binitro-naphthaline along with zinc and sulphuric acid. The author of this paper finds that the body alluded to is bioxy-naphthochinon, which stands in the same relation to naphthaline as alizarine stands to anthracen—that is to say, that naphthazarine—

$$C_{10}H_4\begin{cases}(OH)_2\\O_2\end{cases}$$

is to be considered as the alizarine of the naphthaline series.

Action of Chlorine upon Absolute Alcohol.—This very lengthy essay contains the exhaustive description of a series of experiments made by the author to determine what the final result is of the action of chlorine upon absolute alcohol. The body thereby obtained is termed chloralcoholate—

$$C_4H_7Cl_3O_2 = C_2HCl_3\begin{cases}OC_2H_5\\OH\end{cases}$$

It is a solid substance; crystalline; fuses at 46°; boils at 112·5°; is difficultly soluble in water, by which property this substance is distinguished from chloral hydrate. The theoretical vapour density of the chloralcoholate is 6·68; but it appears that this substance is split up at a higher temperature into chloral and alcohol. The memoir contains an exhaustive discussion, illustrated by a series of formulæ, on the mode of origin of the chloralcoholate from trichloracetate.

Electrolysis of some Chemical Combinations.—N. Bunge.—This paper contains the following sections:—Electrolysis of mercaptans; of (KHS); of sulpho-compounds; of trichlor-methyl-sulphate of potassa, (CCl_3SO_3OK). The author continues his extensive researches on this subject.

Pneumodensimetro Automatico.—A. de Negri.—The description, illustrated by woodcuts, of an ingenious modification of Dr. Bunsen's apparatus for the measurement of the density of gases by means of electricity—that is to say, by the aid of galvanic element and dial apparatus with clock-work, the instrument is made self-indicating.

Test for Detecting the Adulteration of the Colouring Matter of Red Wine.—MM. Cottini and Fantogini.—The authors take 50 c.c. of the red wine to be tested; add to it 6 c.c. of nitric acid, sp. gr. 1·412, and heat to about 90°—95°. Pure and unadulterated wine is not affected, even when heated so for one hour; while artificially-coloured wine is decolourised in five minutes.

Annalen der Chemie und Pharmacie, November, 1870.

This number contains the following original papers and memoirs:—

Allyl-Ether of Formic Acid.—B. Tollens, R. Weber, and Th. Kempf.—This paper is the first of a series forming an exhaustive essay on the allyl group. The following papers belonging to and forming part of this memoir are:—

Preparation of Allyl-Alcohol.—B. Tollens and A. Henninger.

Investigation of Mono-Allyline.—B. Tollens.

Haloid Ether of the Allyl-Alcohol.—B. Tollens.—This paper contains the following sections:—Allyl-bromide; allyl-chloride; allyl-iodide; allyl-sulphide; and allyl-sulpho-cyanide.

Experiments made with the View of Combining Allyl-Alcohol with Hydrogen.—B. Tollens.

Compounds of Allyl-Alcohol with Chlorine and Bromine.—B. Tollens.—This paper contains the following sections:—Chloride of allyl-alcohol; bromide of allyl-alcohol, $C_3H_6Br_2O$.

Synanthrose, a New Carbo-Hydrate of the Synantheræ.—O. Popp.—The substance designated as synanthrose has been discovered by the author in the tubers of some plants belonging to the family of the *Compositæ*, or *Synantheræ*. This new carbo-hydrate is a peculiar kind of sugar, which the author obtained from dahlia tubers (*Dahlia variabilis*) by a lengthy and complicated process of preparation. Pure synanthrose exhibits the following properties:—White-coloured, amorphous, solid body; very deliquescent; readily soluble in water and dilute alcohol; insoluble in absolute alcohol and in ether; chemically and optically inactive; does not reduce alkaline copper solution; incapable of entering directly into fermentation; dilute acids convert it into dextrose and levulose; not coloured brown by a cold solution of caustic potassa, but very readily acted upon by strong sulphuric acid; a cold solution of synanthrose is precipitated by nitrate of silver solution; on heating, the silver is reduced to the metallic state. The elementary composition of this body is $C_{12}H_{22}O_{11}$; that is to say, synanthrose is a metamer of cane sugar.

Inuloid, a Soluble Modification of Inuline.—O. Popp.—The substance which the author describes as inuloid is, in many of its properties, akin to inuline, but differs from it by being readily soluble

in water. The formula of this body is $C_{18}H_{10}O_5+H_2O$. Inuloid does not reduce alkaline copper solution; when boiled with water for some time, this substance is converted into levulose. Inuloid is contained in some not fully-ripened tubers and roots of some plants which, in ripe state, contain inuline.

Researches on the Isomerism of the Benzol Group: the Derivatives from Ethyl-Benzol.—(Thirteenth paper.)—F. Beilstein and A. Kuhlberg.—This memoir contains the following sections:—α and β nitro-ethyl-benzol; ethyl-phenol—

$$C_6H_4\begin{cases}HO\\C_2H_5\end{cases}$$

ethyl-paraoxybenzoic acid—

$$C_6H_4\begin{cases}O.C_2H_5\\CO_2H\end{cases}$$

Constitution of Xylylic Acid, Para-Xylylic Acid, and on a New Modification of Dimethyl-Benzol.—R. Fittig and P. Bieber.—This paper is the fourth portion of an exhaustive memoir on trimethyl-benzol.

Synthesis of Hydrocinnamic Acid.—R. Fittig and J. Kiesow.—This essay contains the following sections:—Phenyl-ethyl-chloride, $C_6H_5.C_2H_4Cl$; phenyl-bromide; preparation of hydrocinnamic acid. The formula of this body is $C_9H_{10}O_2$, while its calcium compound is $(C_9H_9O_2)_2Ca+1\frac{1}{2}H_2O$.

Ethyl-Phenol.—R. Fittig and J. Kiesow.—Ethyl-phenol—

$$C_8H_{10}O=C_6H_4\begin{cases}C_2H_5\\HO\end{cases}$$

is a crystalline solid body, fusing at about 48°, boiling at about 211°, somewhat soluble in water, and very readily so in alcohol and ether. Tetra-bromethyl-phenol—

$$C_8H_6Br_4O=C_6Br_4\begin{cases}C_2H_5\\HO\end{cases}$$

a solid body, crystallising in quadrilateral prisms, insoluble in water, and fusing at 106°; its calcium-salt is $(C_8H_5Br_4O)_2Ca$.

December, 1870.

This number contains the following original memoirs and papers:—

Researches on the Constitution of Twice (Zweifach) Substituted Benzols.—V. Meyer.—This very lengthy essay is divided into the following sections:—Introduction, containing a review of the labours and researches on substitution in general; new method of synthesis of aromatic acids—viz., benzoic, naphtoë, and isophthalic acids; regularity observable in the substitution of benzol derivatives; dibrombenzol; substitution of aromatic amides; sulphanilic acid; formula of benzol; constitution of triderivatives of benzol; on the method of designating the benzol derivatives.

Researches on the Position of the Hydrogen Atoms of Benzol.—H. Hubner and J. Alsberg.—This memoir, akin to the foregoing, not well suited for any useful abstraction, is divided into the following chapters:—Introduction (containing the following brief definition of chemistry—"Chemistry is that portion of molecular physics which treats of the mutual attraction of atoms as units"); aniline from bromnitro-benzols; researches on acetanilide from pure nitrobenzol. The chief result deduced from their researches by the authors is, that the hydrogen atoms of benzol are mutually in the same position.

Journal für Praktische Chemie, No. 17, 1870.

This number contains the following original papers and memoirs:—

Oxidation of Albuminates to Urea.—O. Loew.—This paper contains an account of some experiments made by the author with the view of verifying the correctness of the various statements made by several experimenters, on the successful oxidation of albumen and various protein compounds, so as to obtain urea therefrom. The author's experiments lead to a negative result in this direction.

Some of the Causes by which the Variety of the Crystalline Form of Carbonate of Lime is brought about.—Dr. H. Credner.—This very lengthy essay, illustrated by a series of lithographs, is divided into the following sections:—Introductory observations; crystallo-genetic experiments made with carbonate of lime; experiments made with a cold solution of pure bicarbonate of lime; experiments made with the same solution, with the addition of silicate of potassa; with silicate of soda; with a mixture of the two solutions of silicate; experiments made with a solution of bicarbonate of lime and bicarbonate of strontia; experiments made with a solution of bicarbonate of lime to which a solution of gypsum was added; experiments made with a cold solution of bicarbonate of lime to which salts of lead were added. From the general results of the author's experiments we quote the following:—The addition of certain substances to the solutions of minerals affect the crystalline form and the number of planes of the resulting crystals. The addition of various substances to the solutions of a species of any mineral becomes an impulse to the formation of totally different mineral species. When carbonate of lime crystallises from not too dilute, but perfectly pure, solutions in the shape of calc spar, it assumes the shape of arragonite upon the addition of small quantities of carbonate of lead, sulphate of lime, or carbonate of strontia. The differences of temperature, and of the degree of concentration of the solutions of carbonate of lime, are not, therefore, the only causes of the dimorphismus of carbonate of lime.

Occurrence of Amorphous Native Sulphide of Mercury.—Dr. G. E. Moore.—This paper contains the account of the discovery and mineralogical description of a peculiar mercury ore met with in the State of California, U.S. The mineral referred to is amorphous, coloured like graphite, with a metallic lustre; sp. gr., 7·701 to 7·748; behaves, when heated in blowpipe-flame, like cinnabar; and sublimes when heated in a small flask. Composition, in 100 parts—Sulphur, 13·82; mercury, 85·79; iron, 0·39; quartz, 0·25. Formula, $HgS+FeS_2$. This mineral occurs in abundance in the Bedington mercury mine, Lake County, California.

Two New Compounds of Nicotine with the Chlorides of Zinc and Cadmium.—Dr. H. Vohl.—The double salts herein described exhibit the following properties:—The nicotine-zinc salt is a crystalline body, soluble in water, very difficulty soluble in ether and absolute alcohol, and slightly acid reaction. Formula—

$$(C_{10}H_7N+ClH)+(ZnCl)+4HO.$$

The cadmium-nicotine salt is also crystalline, and agrees in its general properties with the zinc salt. The formula of the cadmium salt is $(C_{10}H_7N+ClH)+(CdCl)+2HO$.

Presence of Amygdaline and a Substance Resembling Asparagine in the Seeds of Vicia Sativa (Vetch).—H. Rittshausen and Dr. U. Kreusler.—Only a small and incomplete portion of this paper is published; it will be continued in the next number of this periodical.

Journal für Gasbeleuchtung, November, 1870.

The original papers contained in this number bear chiefly on the water supply and waterworks of some towns in Germany.

NOTES AND QUERIES.

Solubility of Tin in Nitric Acid.—Neither Mr. Hay nor Mr. Scott has mentioned the fact, which I remember observing when I once had some tin dissolved in dilute nitric acid, viz., that the solution is accompanied, as might be expected, with an evolution of ammonia. —H. B. GIBBINS.

Solubility of Tin in Nitric Acid.—Can any of your readers point out any paper in which it appears that the fact of the solubility of tin in nitric acid was published previously to my announcement of it in your journal of December 16th, 1870? I myself know of no such paper.—GEORGE HAY.

Emerald Green.—(Reply to "Emerald.")—There are various methods in use for making the green colour you refer to, among these we quote the following:—Take one kilo. of pure sulphate of copper free from iron, dissolve it in twelve litres of water, and add thereto 350 grs. of arsenious acid, and one kilo. of refined pearl-ash, dissolved together in eight litres of water; the latter solution should be added to the former, care being taken to stir the fluids. The ensuing precipitate should be washed with warm water and dried. For further information consult Gentele's "Lehrbuch der Farbenfabrikation," often quoted by us previously.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 16th.—Medical, 8.
TUESDAY, 17th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Zoological, 9.
WEDNESDAY, 18th.—Meteorological, 7.
—— Society of Arts, 8.
THURSDAY, 19th.—London Institution, 7.30.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Royal, 8.30.
—— Chemical, 8.
—— Royal Society Club, 6.
FRIDAY, 20th.—Royal Institution, 9. Professor Tyndall.
SATURDAY, 21st.—Royal Institution, 3. Rev. W. H. Channing, "On Laws of Life Revealed in History."

TO CORRESPONDENTS.

W. Hamilton Reid.—Johnston's "Lectures on Agricultural Chemistry" is the best work. If it is out of print you can see it at the Library of the Commissioners of Patents.

J. D. M.—As far as we can make out your writing of the words, the translation would be "Nordhausen fuming double vitriol" but, in all probability, the words refer to fuming, or so-called Nordhausen, sulphuric acid.

S. E. Phillips.—Declined with thanks.

W. F. K. Stock.—The article would occupy a whole number of the CHEMICAL NEWS; it has already appeared. You will find full particulars in the 3rd edition of Mitchell's "Manual of Practical Assaying."

Delphinus.—Ure's Dictionary is published by Longmans and Co., price £4 14s. 6d.; it probably contains the information you require.

China.—There is no English translation. Messrs. Hachette and Co., Foreign Booksellers, Strand, will supply you; the price is about 17s.

BOOKS RECEIVED.

The Retrospect of Medicine, edited by W. Braithwaite, M.D. and James Braithwaite M.D. Lond. Vol. lxii. London: Simpkin, Marshall, and Co.

Lessons in Elementary Physics. By Balfour Stewart, LL.D., F.R.S. London: Macmillan and Co.

Beet-Root Distillation, containing a Report on Beet-Root Distillation, and the Savalle Stills. By Dr. Augustus Voelcker, F.R.S. Popular Science Review.

Introduction to the Study of Inorganic Chemistry. By William Allen Miller, M.D., LL.D., F.R.S., &c. London: Longmans, Green, and Co.

A Laboratory Text-Book of Practical Chemistry. By W. J. Valentin, F.C.S. London: John Churchill and Sons.

Inaugural Lecture of the Industrial and Technological Museum.

Journal of the London Institution.

Henderson's Patent Processes for Refining Cast-Iron and for the Production of Steel and Wrought-Iron.

Essays on the Use and Limit of the Imagination in Science, By John Tyndall, LL.D., F.R.S. London: Longmans, Green, and Co.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 582.

ON THE

EXAMINATION OF THE BESSEMER FLAME WITH COLOURED GLASSES, AND WITH THE SPECTROSCOPE.

By J. SPEAR PARKER.

I HAVE been engaged for some time in investigations as to the nature of the Bessemer flame at the Cyclops Steel and Iron Works, on behalf of Messrs. Charles Cammell and Co., and as the subject is one of considerable interest at present, I forward you the results I have obtained, with their kind permission.

The combinations of glasses used by Mr. Rowan and Professor Silliman for observing this flame are somewhat similar in their effect, the two light yellow in the one case being nearly equivalent to one dark yellow in the other. The combination I used was one cobalt-blue glass of rather light shade, and one amber-coloured; too deep a blue should be avoided, otherwise the flame merely shows varying shades of crimson. The appearances observed were similar to those recorded by Professor Silliman. On first turning on the blast, the flame appeared of a reddish orange; after the lapse of a few minutes, this gradually changed to crimson, first in flashes, afterwards continuously; the sodium line appearing in the spectroscope at exactly the same time, and corresponding also to the flashes; after a few more minutes had passed, the flame altered to yellow, and, at that time, the characteristic Bessemer spectrum appeared, flickering at first like the sodium line; when it became steady, the flame, when viewed through the coloured medium, appeared to consist of a sheath of a light yellow colour, the inner cone being rose-red, while the upper part of the flame was edged with crimson; this appearance was maintained throughout the rest of the decarbonisation, only varied by occasional flashes of a deeper red, or of a greenish hue. When the termination of the reaction was attained, the flame, after a few premonitory flashes, changed again to the crimson colour. The appearance of a crimson ring round the mouth of the converter I am inclined to attribute to irradiation.

With regard to the utility of this method, it is evident that, as the changes seen are owing to the same phenomena as those observed by the naked eye, it cannot be more accurate than the method now in general use, the experienced eye of the workman being able to detect the change with surprising precision; it has, however, the advantage that more inexperienced hands may thus find a safe guide, and it is especially of benefit in protecting the eyes of the observer from the bright glare of the naked flame, a light so intense that it must, I think, in the long run, prove very injurious to the sight.

The indications of the spectroscope, however, have a different basis. The instrument I have used in my investigations is of the direct vision form, containing five glass prisms, and, although for comparisons with other spectra and for scientific investigations, the ordinary form is, undoubtedly, best fitted, I think that, should the spectroscope be more generally introduced and placed in the hands of those unaccustomed to the use of scientific instruments, the direct vision is preferable, for after once focussing it may be used like a telescope, and is less liable to need re-adjustment.

The spectrum, as observed with this instrument, agrees very closely with the one represented on page 125 of the first edition of Roscoe's "Spectrum Analysis." Between the lithium (a) and sodium lines appears the first prominent group in the red, consisting of two bright lines in close juxtaposition, a band of bright light gradually fading towards the least refrangible end of the spectrum; shortly after this is a bright line in the orange-red; and three narrow and feebly luminous lines occur between this and the brilliant sodium lime, which is closely followed in the greenish yellow by two lines of moderate brightness. At the commencement of the green occurs another most characteristic group; it is very similar in general appearance to the one mentioned in the red, consisting of two broad very bright green lines in close proximity, with a band of light fading towards the yellow. In each of these cases, the edges of the lines are hazy; in the green group, however, a narrow line may be observed on each side of the two brightest; after a short gap in the spectrum, another group of five bright green lines occurs; most of these are narrower with well-defined edges. The apparent presence of an absorption line in this group is merely owing, I think, to the effects of contrast. Beyond this, occur two sharply-defined lines in the greenish blue. I have not succeeded in seeing with certainty any more refrangible lines in the Bessemer spectrum, but such would, doubtless, be visible with a more perfect instrument. The red potassium line was not very readily observed on account of its occurring on the extreme left of the field of view, and its comparatively feeble luminosity. The above mentioned are all I have been able to define, but, towards the close of the process, when the temperature becomes most intense, numerous others appear, those portions of the spectrum which previously seemed blank being filled with fine lines; this is especially observable in the considerable space extending from the lithium line to the first prominent red group.

With regard to the order of their appearance in the spectrum, after the sodium lime, I have always observed the red and the first green group mentioned above together with the intervening lines appear simultaneously; at first alternately brightening and disappearing, then continuously. The lithium line is rather variable, sometimes becoming visible before, sometimes after, the first appearance of these lines. The more refrangible green group and the lines in the geenish blue usually become visible rather later; probably, however, this is owing to their inferior brightness. When the time is reached for the termination of the blowing, the whole of the lines disappear almost at the same moment, except the two due to the presence of sodium and lithium, which remained whenever sufficient time was left to observe them.

Dr. Marshall Watts has called attention to the peculiar spectrum of the flame which is produced when spiegeleisen is added to the decarbonised iron; on most occasions the spectrum I have seen corresponds with his description: once or twice I have observed, in addition, a group of several well-detailed lines in the bluish violet, these being developed only when the flame is very strong, in consequence of the charge having been slightly overblown; while, sometimes, the ordinary spectrum of the Bessemer flame is alone produced. Although, at first sight, these two appear to differ considerably, it is evident as he has shown, that it is merely an alteration of the relative intensity of the various lines. The peculiar spectrum of this flame is especially marked by the great prominence and brightness of many of the lines in the green, and hence the flame appears of a greenish yellow when viewed through the coloured medium.

The indications of the spectroscope, and the appearance of the flame, as seen through the coloured glasses are, therefore, found to be in perfect accordance; the continuous spectrum without any bright lines corresponds to the reddish orange flame; when the spectrum with the sodium line is produced the flame appears crimson; as soon as the characteristic Bessemer spectrum becomes visible the flame alters to a light yellow; and at the termination of the decarbonisation, when the continuous spectrum with

the sodium line is again produced, the flame at the same moment alters also to crimson as before.

Professor Lielegg states that he has seen the Bessemer spectrum when the converter has been heated with coke merely; I have not been so fortunate, as I have never seen, under such circumstances, more than the red potassium, the sodium, and the lithium lines.

All the earlier observers concurred in attributing the variable lines to the spectrum of carbon in some form: the statement that they are due to the presence of manganese, therefore, will occasion considerable surprise. While it may be that some of the sharply-defined and more refrangible lines correspond with the spectrum of that element, it does not seem likely that the first green group for instance, or the prominent red group, which are so similar in their general appearance to the bands in the usual carbon spectrum, can be owing to that cause; nor does Mr. Huggins describe any lines as occurring in those portions of the manganese spectrum (*Philosophical Transactions*, 1864). Their appearance, at the time when decarbonisation commences, and their disappearance at the moment when it is completed, afford very strong presumptive evidence in favour of the carbon hypothesis, but an observation I was fortunate enough to make, places it, I think, almost beyond a doubt.

The peculiar spectrum of the flame which rushes out of the converter when the spiegeleisen is added has already been adverted to; this is also observed when the charge is poured out into the ladle. I was very much astonished, however, to see it produced from the stream of steel pouring into the ingot moulds, and, on looking for the cause, I observed a large flame rushing out of the mould; on repeating the observation I only saw the spectrum when this flame was produced, corresponding also with it in comparative brightness. It is caused by the *graphite* with which the moulds are lined to fill up any cracks or crevices, and thus facilitate their ready separation from the ingots, and must, therefore, be due to the combustion of carbon by the air carried down with the stream of metal at an intense white heat. The brightest lines only were observed, especially the two green groups, and they corresponded with the altered spectrum produced by the spiegel flame.

To ascertain the nature of the Bessemer spectrum with absolute certainty, observations are required with more powerful and delicate instruments than those hitherto used, but I think there is little doubt that the most characteristic portion of the spectrum will be found to be owing to the presence of carbon in some form.

AN ACCOUNT OF THE MANUFACTURE OF COPPER ON THE TYNE.*

By R. CALVERT CLAPHAM.

The manufacture of copper, as now extensively carried on, has introduced a new industry in this district. Up to the year 1850, no copper was produced on the Tyne; in 1851, J. and W. Allen commenced soda works at Wallsend, to work out Mr. Longmaid's patent, and they extracted as much copper as produced four tons sulphate of copper weekly; a few years later Mr. Gossage erected copper works at Wellington, Mr. Russell at Walker, and Mr. Mease at Jarrow, to work up the poor copper ores then chiefly obtained from Cornish and Irish pyrites. The regulus, or precipitate, was sent to Swansea, to be smelted for copper. H. L. Pattinson and Co. began to smelt copper ores, obtained from burnt pyrites, in 1858; the regulus also being sent to Wales. Up to this date the total copper regulus, &c., made on the Tyne, would not represent more than 400 tons of copper annually.

In 1865, copper works were erected at Hebburn, to carry out the so-called Henderson process, for extracting copper by the wet method, from ores obtained from Spanish pyrites. Since that date there has been a rapid increase of production in the older works, and recently others have been erected for a similar purpose by the Bede Metal Co., at Jarrow.

The total quantity of copper produced on the Tyne in 1869 was 4100 tons, and of this quantity about 280 tons consisted of sulphate of copper, and the value of the products was about £340,000. This production has been greatly extended in the present year. From the facilities now at hand for the disposal of the burnt copper pyrites produced in the district, instead of sending them all the way to Swansea, and the cheap rate at which copper pyrites can be supplied, it appears pretty certain that this ore will soon take the place of non-cupreous ores. The total consumption of pyrites, of all kinds, in the United Kingdom, for 1869, was nearly 400,000 tons, namely:—

	Tons.
Imported from Norway	63,091
,, Holland	13,983
,, Portugal	140,805
,, Spain	99,648
,, Other parts	2,420
	319,947
Produced in Ireland	56,291
,, Cornwall and other parts ..	19,658
	395,896

And of this quantity 265,453 tons consisted of copper pyrites, namely:—

	Tons.
Imported from Norway	25,000
,, Portugal	140,805
,, Spain	99,648
	265,453

Large as this importation is, it may be interesting to know that the importation of pyrites for this year will not be far short of 400,000 tons. The importance of this fact on the future development of the soda trade cannot be exaggerated, and, indeed, these manufactures—soda and copper—are every year becoming more dependent on each other. The erection of copper works in this district has already had a marvellous effect in increasing local importations, and at the same time reducing the cost of the sulphur to the soda maker, the price having fallen 40 per cent since 1865.

As the plan of manufacture generally conducted in the district is well known to most of the members, I need only briefly refer to it. The pyrites most suited for the purpose is obtained from Spain, and contains less silica and other impurities than most other pyrites.

In the first place the sulphur is nearly all extracted by the soda maker in producing his sulphuric acid; the ores are then sent to the copper works: at this stage the better kinds contain about 3 to 5 per cent copper, 4 per cent sulphur, 4 per cent silica, small percentages of silver and lead, and the balance is peroxide of iron. It is mixed with a certain weight of common salt, the quantity depending on the percentage of sulphur left after burning. The whole is ground to a fine powder, and is then placed in long reverberatory furnaces, which are kept at a moderate heat. During this operation the sulphur is converted into sulphuric acid, and the salt is at the same time decomposed; the hydrochloric acid acts upon the copper, and, provided the heat in the furnace is not kept too high, the whole of the copper is rendered soluble and can be washed out of the residue. A part of the chloride of copper is, however, driven off by the heat and passes off into the condensers along with the free hydrochloric acid, and is there condensed. The acid solutions from the towers is

* Read before the Newcastle-upon-Tyne Chemical Society.

of a distinct greenish blue colour, showing the presence of copper.

When the ground material in the furnace is complete, it is thrown into wooden tanks, and digested in water and the acid solution from the condensers, the acid assisting most materially in dissolving out the metals. The liquors run off from the tank are necessarily of a mixed nature, and consist of chlorides of copper, silver, and lead, and undecomposed common salt, also sulphates of soda and lead, &c.

To obtain the copper, the liquors are treated with old scrap iron or spongy metallic iron, which is made from the residue ores, by heating with coal in a muffle furnace. In both cases the copper is precipitated, but when spongy iron is used the action is much more rapid. The precipitate thus obtained is frequently washed in water to free it as much as possible from the salts of iron, soda, &c., after which it is allowed to drain and partially dry. In this state it is smelted in an ordinary reverberatory furnace, the first smelting yielding what is termed "pimple copper." This is again slowly melted in a similar furnace, with a free current of air passing over it for the purpose of oxidising the impurities; it is run out and forms what is termed "blister copper," which is refined into "cake or ingot copper" for the market.

The residue left in the tanks consists of nearly pure peroxide of iron, and is extensively employed for fettling in puddling furnaces and in blast furnaces in the place of hematite ores. The analysis may be roughly stated as under:—

	Tons.
Peroxide of iron	90·00
Silica	6·00
Water, &c.	4·00
	100·00

Most of the Spanish pyrites contain also notable quantities of both silver and lead, and in some cases gold; but until very recently no attempt has been made to separate these metals. M. F. Claudet has, however, patented a process to effect this object, which may be briefly described as under. The ore is treated as above described: the first two or three washings, M. Claudet states, contain the silver, the chloride of silver formed during the calcination being rendered soluble in the large excess of common salt which is used. The solutions to be treated for silver are run into large vats, where a soluble iodide is added to precipitate the silver. The precipitate thus collected is a mixture of iodide of silver and sulphate of lead, with salts of copper. The latter are dissolved out by weak acid, and the remaining precipitate is decomposed by metallic zinc, which reduces the iodide of silver. The zinc iodide which is formed is used to precipitate chloride of silver from other solutions. The precipitate also contains gold.

It will be seen from the above short statement, that all the metals in the ores can be extracted and made commercially useful, and that the only article produced in any quantity, and not hitherto utilised by the process, is sulphate of soda. Experiments upon a large scale have already been carried out by Dr. Merz and Mr. Napier, to recover it from the waste liquors; and it may reasonably be expected that in time it also will be obtained.

But if we leave our own locality and glance for a moment at the production of copper in the United Kingdom generally, we find that the native mines, which have been worked for centuries past, reached their maximum production in 1860, viz., 15,968 tons. As the importations from abroad increased, and the production of copper from burnt pyrites gradually assumed greater importance, the mining of native ores has been proportionately abandoned, and the weight raised in 1869 amounted to only 8291 tons, equal to a reduction of nearly 50 per cent.

The following figures represent the production, importation, exportation, and consumption of copper in 1869:—

	Tons.	Tons.
Copper made from native ores		8291
Viz., from Cornwall and Devon	6794	
,, Wales	346	
,, Isle of Man	30	
,, Ireland	1022	
,, sundry precipitates	99	
	8291	
Copper made from burnt pyrites ..		7600
Viz., from the Tyne	4100	
,, Lancashire and other places	3500	
	7600	
Imports (consisting of ores, regulus, bars, rods, &c., calculated as pure copper	63,097	
	78,988	
Viz., from Chili	42,000	
,, Australia	7500	
,, Cape of Good Hope, Norway, North America, and other places	13,597	
	63,097	
The exports of copper manufactured in England are	42,569	
Do. foreign copper ..	12,309	
	54,878	

The consumption of copper in England was as under:—

	Tons.
1864	20,120
1865	26,514
1866	28,326
1867	20,305
1868	17,400
1869	21,665

Or an average of 22,388 tons annually.

In conclusion, I have to thank the copper manufacturers for the prompt manner in which they have given me all the information required, and Mr. R. Hunt, F.R.S., for his kindness in overlooking my figures, and for valuable information.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from p. 11.)

I STATED that exposure to a red heat was found by Pasteur to act effectually in destroying the vitality of these little particles, and in every case in which he used air which had been subjected to that heat, he found that the air was incapable of sowing any of these organisms in liquids even the most favourable to them. There was, however, still one remarkable exception, which was presented by the experiment of Gay-Lussac, to which I alluded some time ago. He found that when he used a mercury trough, which he selected as giving him the best condition for the purpose, he got these little cells produced from the air which had been calcined. Now, Pasteur found that mercury exposed to the air, as it is in these operations, has adhering to it a number of these little germs, and that when no more than the ordinary precautions are taken for cleansing the mercury, that it has got with it a considerable variety of such little organisms, which,

* The Cantor Lectures. Delivered before the Society of Arts.

if placed in a suitable material, develop themselves and grow quite well. He proved this in various ways. For instance, some of the little bulbs which had been sealed up whilst full of fermentable liquor and steam, and which had been kept for some time in a warm chamber, so as to be certainly free from vital organisms, were opened under mercury, so as to allow the ends of the tubes to be filled with mercury. He then lifted it up, so that nothing came into contact with the liquid but mercury, and passed into them sometimes air which had been passed through a red-hot platinum tube, and sometimes oxygen gas given off from molten chlorate, where certainly there would be nothing of organic life present, and in almost all these cases he found that organisms developed themselves. He attributed this entirely to the mercury, because when that was absent the result was the opposite. In order to prove this point more decisively, he took a liquid which was capable of decomposing, kept it for some time in a quiescent state, and then allowed a drop of mercury, in the state in which he had been using it before, to flow into it, and put the mixture into his warm chamber. He soon found that the mercury had carried in the germs of these organisms, and that they developed themselves quite well in it. Certainly anyone unaccustomed to such accurate precautions could hardly have anticipated such a result as that, and a result which is, I think, most instructive, as showing what extraordinary precautions are needed, in order to prevent the entrance of these excessively small particles into the materials which we are working with. Side by side with this, I must mention another result of Pasteur's for it was, perhaps, hardly less startling, and that was, that when, instead of taking the liquid which I mentioned to you just now, yeast-water and sugar, he took common cow's milk, or at all events, the mixture which is sold by that name, and boiled it, with a view of destroying any organisms that might be in it, and then he sealed up the bulb while still full of steam, so that no air could get into it, and when he kept such sealed-up bulbs for some time in a warm chamber, he found clear evidences of decomposition; he found a turbidity in the substance, a curdling of the nitrogenised materials of the milk; and on taking out some of it, he found it was swarming with little animalculæ; and yet he had boiled the milk for a considerable time, and had closed the vessel whilst the ebullition was still going on, so that no air could have carried the germs into it before it was closed, Still, there were little organisms unmistakably present. He then modified his experiment in this manner: he boiled his milk at a higher temperature. I need hardly tell you how that can be done. You are, of course, aware that the temperatures at which water, or milk, or any liquid boils are different, according to the pressure which the air exerts upon it; that is to say, if you were to boil water here, and then if you were to carry it to the top of St. Paul's and notice the temperature in each case, you would find that at the greater height it would boil at a lower temperature. If, in like manner, you carried it down to the bottom of a deep mine, and boiled it there, you would find the temperature would be higher; the greater the pressure of the superincumbent air, the higher the temperature at which any liquid boils. Pasteur wanted to make his milk boil at a higher temperature, and for that purpose he resorted to a very simple device. He had a long tube attached to the vessel in which his milk was boiling, bent over at the top, and brought down into a glass jar containing mercury to the depth of fifteen inches or more. Of course, under these circumstances, the steam, which was being formed in the vessel, has to force its way up against the pressure of this mercury; the pressure of these fifteen inches of mercury was added to the pressure of air, and a total pressure was obtained, about half as much again as the pressure of the atmosphere amounted to. Of course, the milk had to boil at a higher temperature, corresponding to this higher pressure; and what did he find then? He proceeded, as before, with the experiment, closing the vessel while it was boiling, and not letting any air into it. He then kept it, and he found that no organisms appeared, even on keeping it a very long time; and he was, therefore, led to conclude that the milk must have contained in it some germs which could withstand the temperature at which the milk was boiling at first, but the vitality of which was destroyed by exposure to the higher temperature to which he exposed it in the subsequent experiment. He had reason for that, for other experiments had been made by himself, and by various other philosophers, which proved that many species of organisms can withstand a very high temperature without losing their vitality. In that respect, there are great differences amongst these little organisms which are remarkable and interesting, and will, no doubt, be of value to future investigations. To give you an idea of the great variety presented by them in their power of witshtanding heat, I may mention, that if I were to heat the contents of this carboy, in which the alcoholic fermentation is going on, to 60° C. (100° being boiling-point centigrade), which is rather more than half, the fermentation would be completely arrested, and the yeast cells would be killed. On the other hand, the particles in milk are capable of withstanding 100°. Pasteur connected that fact with the circumstance that milk is alkaline, whilst this liquid is acid, and, as a rule, acid liquids destroy the vitality of these organisms at a lower temperature than alkaline liquids. That is not all. There are in the particles themselves great differences in their power of withstanding heat. Amongst the experiments which are particularly remarkable in that point of view, I ought to mention some with regard to the little spores of mould, and such-like things; for instance, the *Penicillium glaucum* and some others. M. Pasteur collected some of these; and after taking a little piece of asbestos, or mineral flax, as it is sometimes called, and heating it in a flame, so as to destroy anything adhering to it, he put it carefully into a vessel in which some of this mould was growing, and moved it about, so that a number of particles of the seed of the mould might adhere to it. He then heated the asbestos thus coated with dust to 120° C., a higher temperature than that to which the milk had been exposed; but after putting it into a liquid capable of feeding mould, he found that the mould made its appearance in considerable quantity, so that the germs of that particular organism were not destroyed by 120° of temperature. He even went higher, as far as 125°, and found that that was not enough, but a little over 125° killed them; 130° they cannot stand, so that, according to these observations, the limit appears to be between 125° and 130°.

In all the cases of which I have been speaking, the ferments (because all these organisms are in their nature and functions analogous to the common ferments) were removed from the substances which were employed before the air and such like materials carrying the germs, were brought in contact with them.

With regard to processes for arresting fermentations and decomposition in liquids in which they are taking place, a number of observations have been made which are of considerable practical as well as theoretical importance, in relation to the results which I have been stating. Of course, mere heating, carried to a sufficient intensity, will arrest any process of fermentation or putrefaction which may be going on in a substance, and the applications of that process are, of course, exceedingly numerous and important. The only thing is, that we do not know, and it would be most hazardous to suppose that, in any particular case, we can name beforehand the temperature requisite to destroy a particular organism. If any observer were to say that he has exposed a mixture to 100°, and, therefore, the organism must be destroyed, experience would refute him; if he said he had exposed it to 110°, or even 120°, experience again would refute him; but if he had exposed it to 150°, and asserted that he must have destroyed them, it is quite possible that experience might show that there are organisms which will resist even that temperature. It would have been almost impossible, some time ago, to admit, and we

could not have admitted, that these organisms would have withstood the temperature which they have been found to withstand; and, therefore, what temperature is sufficient to destroy the organism in any case must be found by experiment, and that alone. Amongst other conditions for arresting the process of decomposition or putrefaction, which are in their nature like those of fermentation, I ought to mention the process of drying. All the processes of fermentation which I have been speaking of, and all others which I could tell you of, are accompanied by moisture. Moisture is present, and is essential to them; in fact, these little organisms are exceedingly soft, wet things; moisture constitutes a great part of their substance, and in a dry medium they cannot live, or if the substance were dried, they would be destroyed by it. Applications, therefore, of a mere drying process are amongst the most important and interesting of this class of agencies. Many of them are well known; for instance, the ordinary process for preserving fruit by means of drying it. Germs of putrefaction or decomposition may be present in the fruit; but if you merely take away the greater part of the moisture, you render the substance incapable of decomposing, Among the agents which serve for that purpose, there are some which abstract the water, not in a state of vapour, but in the liquid state; for instance, common salt. If you put a piece of fresh meat in contact with salt, or rub it over with the salt, the salt gradually absorbs the water, and draws the water out of the meat. The action is truly a drying action upon the meat, and it is effectual by a perfectly similar process to that which would go on if you exposed the meat in a dry chamber to a current of warm air. In like manner, of course, it is known to many persons that sugar is used just as salt is, to remove water from substances containing it in any quantity. If you were to rub any fruit or animal substance with a sufficient quantity of dry sugar, you would get the sugar dissolved by the water, which would be removed from the materials; and amongst the observations which are made in common life, there are some which bear, in an interesting and instructive way, upon what I have been saying to you. For instance, I have heard it said that ordinary jam—fruit and sugar, which have been boiled together for some time—keep better if the pots into which it is poured are tied up whilst hot. The observation has been so frequently made that one was inclined to think that there must be some truth in it; and I think if we admit that the paper can act as a strainer in the same way as the cotton wool, you will see at once that it must be as people suppose. Take two cases. Suppose one pot of jam, allowed to cool before it is tied down—little germs will fall upon it from the air, and they will retain their vitality because they fall upon a cool substance; they will be shut in by the paper, and will soon fall to work decomposing the fruit. If you take another pot, perfectly similar, filled with a boiling-hot mixture, immediately cover it over, though, of course, some of the outside air must be shut in, any germs which are floating in it will be scalded, and, in all probability, destroyed, so that no decomposition can take place.

Amongst other materials which serve to arrest fermentation, there are several chemical agents of considerable energy, which are frequently employed for that purpose. Amongst the foremost, I ought to mention creosote, the active material of smoke; and I have no doubt that the antiseptic action which smoke is said to exert upon ourselves—because it is said that smoke is very wholesome, although I do not lean to that view myself—is due to the presence of this creosote or carbolic acid. Everyone is aware that one process for preserving meat, which has long been in use, is to suspend it in a chimney in which the smoke of wood is present. The smoke of wood, like that of coal, contains this substance, or one nearly allied to it, and amongst antiseptic agents it is one of the most energetic. A small quantity of this carbolic acid thrown into that fermenting liquid would completely kill the organisms. In the same way, if I were to introduce a little sulphurous acid into any of these mixtures, I should immediately kill the organisms and arrest the fermentation. Sulphurous acid is now largely used for this purpose, being employed, in combination with lime and water, to saturate the casks in which beer is to be stored, so that the wood being impregnated with it, any germs which might find their way from the atmosphere, and set up a process of decomposition, are arrested and destroyed. Another very powerful antiseptic agent is prussic acid, one of the most powerful of poisons to all animal organisms, and it is particularly powerful in stopping the action of these ferments. Another substance which I think is worthy of consideration, in the same point of view, is a mixture which is, to a great extent, of unknown composition. I refer to the poisonous matter which is given off in tobacco smoke. It must, I think, when present in the air, exerts a very powerful antiseptic action upon these organisms. It has been shown, by the experiments of Professor Tyndall, that in the lower vessel of the lungs there are considerable deposits of the dust which floats about in the air; and we are, of course, exposed in that manner to the action of a number of the seeds of these ferments, and, for aught we know, of diseases, because many malignant diseases are attributed to processes of decomposition analogous to those which we have been considering; and they may be, and, as some persons think, are carried by germs in the air, in the same way as those I have been mentioning. Now, any powerful substance which would kill these germs must, of course, exert a beneficial action, and when persons are exposed to the smoke of tobacco, there is no doubt that some of it enters the lungs with the air which is vitiated, and that some of the smoke must be deposited in the lower passages of the lungs with these little mischievous germs, and must certainly somewhat astonish them.

I have here several little apparatus, all alike in their general arrangement; each consist of two little tables, connected together in such a way that air may be made to pass through both of them in one direction, but not in the other. A tube goes from the top of one into the liquid in the second, and the tube from this second passes on into the air; and these bottles can, by means of an aspirator, be supplied with air which has been strained through cotton wool, and no other air can pass into them. The bottles contain the same mixture which I have been talking about so much, yeast-water and sugar, a liquid which decomposes in almost any way you like, for almost all these germs live in it more or less vigorously. After the liquid was put in, it was kept boiling for a considerable time, so that there is, I trust, in the bottles no living organism whatever; in fact, I have reason to believe that any organisms which may have been there have been destroyed by the high temperature to which they were exposed. I might draw hundreds of cubic feet of air through that apparatus, and it would remain entirely unchanged. Next Monday we will resume this again. We will also examine this particular apparatus, which is exactly the same, with this exception, that after the whole had been filled in the manner I have stated, a little mould was introduced by a separate tube into the first bottle. The apparatus will be taken back to University College, where it will be put into the warm chamber, where the organisms will be developed; and I have no doubt the liquid in the first bottle will be in a state of active decomposition before the day is over. Then next week, we will draw purified air, which, by itself, has no action on the liquid, and see whether it will carry any germs into the second bottle. I have no doubt that, by Monday next, there will be enough mould upon it to enable us to perform the experiment; and I shall then also have the pleasure of telling you of some applications which M. Pasteur has made of his theoretical results to practical purposes such as the preservation of wines and such-like matters.

(To be continued).

CHEMICAL TABLES ACCORDING TO THE THEORIES OF MODERN CHEMISTRY.*

By Professor ALBERT R. LEEDS.

(Continued from vol. xxii., p. 306.)

TABLE III.

Revised Atomic Weights according to the Ancient Chemistry. H = 1.

Element.	Atomic weight.	Authority.
Aluminum	13·740	Dumas.
Antimony	122·340	Dexter.
Arsenic	75·000	Pelouze.
Barium	68·510	Dumas.
Bismuth	210·340	,,
Boron	11·000	,,
Bromine	79·970	De Marignac.
Cadmium	56·000	C. v. Hauer.
Cæsium	133·000	Johnson and Allen.
Calcium	20·010	Dumas.
Carbon	6·000	,,
Cerium	45·644	C. Wolf.
Chlorine	35·500	Dumas.
Chromium	26·270	Berlin.
Cobalt	29·540	Dumas.
Columbium	49·225	Rammelsberg.
Copper	31·720	Erdmann and Marchand.
Didymium	47·920	De Marignac.
Erbium	56·300	Bahr and Bunsen.
Fluorine	19·000	Louyet.
Glucinum	9·290	Awdejew.
Gold	196·730	Berzelius.
Hydrogen	1·000	Dumas.
Indium	37·813	Winkler.
Iodine	127·000	Dumas.
Iridium	98·560	Berzelius.
Iron	28·000	Erdmann and Marchand.
Lanthanum	46·400	Mosander.
Lead	103·500	Dumas.
Lithium	7·000	Troost.
Magnesium	12·300	Dumas.
Manganese	27·480	,,
Mercury	100·100	Erdmann and Marchand.
Molybdenum	48·000	Dumas.
Nickel	29·510	,,
Nitrogen	14·000	,,
Osmium	99·400	Berzelius.
Oxygen	16·000	Dumas.
Palladium	53·280	Berzelius.
Phosphorus	31·000	Schrötter.
Platinum	98·940	Andrews.
Potassium	39·130	Stas.
Rhodium	52·160	Berzelius.
Rubidium	85·400	Bunsen.
Ruthenium	52·100	Claus.
Selenium	39·620	Berzelius.
Silicon	14·010	Dumas.
Silver	107·950	Stas.
Sodium	23·050	,,
Strontium	43·740	Dumas.
Sulphur	16·000	,,
Tantalum	91·000	Rammelsberg.
Tellurium	64·500	Dumas.
Terbium	37·680	Delafontaine.
Thallium	203·000	Crookes.
Thorium	50·500	Berzelius.
Tin	59·030	Dumas.
Titanium	25·170	Pierre.
Tungsten	92·000	Dumas.
Uranium	59·430	Ebelmen.
Vanadium	51·330	Roscoe.
Yttrium	30·850	Bahr and Bunsen.
Zinc	32·530	Erdmann.
Zirconium	33·600	Berzelius.

(To be continued).

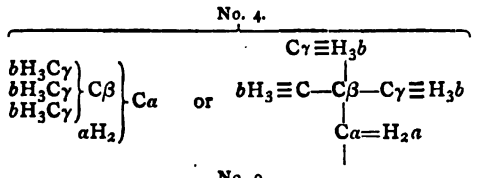
* Communicated by the Editors of the *Journal of the Franklin Institute*. From advance-sheets.

THE ISOMERS OF AMYL.

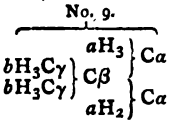
By O. LOEW.

In the CHEMICAL NEWS, vol. xxii., p. 230, Mr. Herbert McLeod undertakes to prove that the number of the isomers of amyl have been over-estimated in the table given by me. It is not difficult to prove the contrary, and to show that the real cause of his differing opinion is that he did not pay sufficient attention to the relative importance of the atoms in different positions. We have to take into consideration not only the four-atomic value of carbon, but also the relative effectiveness. Let us, for example, compare the formulæ Nos. 4 and 9, which are, according to Mr. Herbert McLeod, identical.

No. 4.



No. 9.

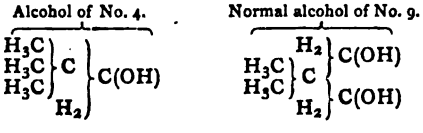


It will be seen at the first glance that the carbon atom α has a higher relative degree than the atom β, and this again another than the more subordinate carbon atoms, γ. When we now compare No. 4 with No. 9, we observe that in No. 4 there are three carbon atoms of the lowest order, γ, and one of the highest, α; while in No. 9 there are two of the lowest, and two of the highest order. In a similar manner, we have hydrogen atoms of a higher degree, a, and of a lower, b. Thus we have in No. 4 only two "typic" hydrogen atoms, while in No. 9 we have five of them.

The hydride of No. 4 has been prepared recently by M. Lwow, in St. Petersburg*; he calls it "tetra-methyl-formen." M. Lwow obtained this body by the action of iodide of "trimethyl-carbinol" upon zinc-methyl; he will probably obtain an isomeric body on treating chloride of aceton with zinc-methyl.

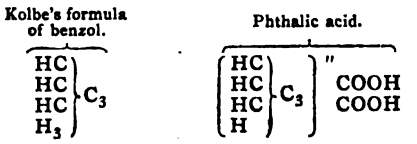
Kolbe, in his theory, pays special attention to the different intensities of the atoms in different positions, and, based upon this principle, predicted the existence of many combinations—as, for example, the isomeric cyanides, isomeric ureas, secondary, tertiary, and dicarbolic alcohols; the mere atomicity is not always sufficient. The normal alcohol, corresponding to a dicarbol, will be a bi-acid alcohol, different from so-called glycols.

Alcohol of No. 4. Normal alcohol of No. 9.

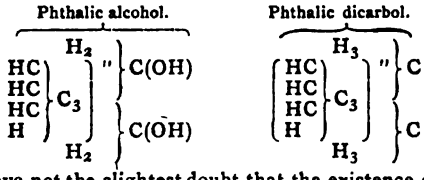


As regards the aromatic series, an alcohol of a dicarbol has already been prepared—viz., the phthalic alcohol, by Kolbe and Wischin.† The following formulæ will show the structure of this interesting combination:—

Kolbe's formula of benzol. Phthalic acid.



* *Zeitschrift für Chemie*, November, 1870.
† *Zeitschrift für Chemie*, 1867.



I have not the slightest doubt that the existence of such dicarbolic alcohols will be proved for the fatty series also.

City College, New York, December, 1870.

ON THE STEARIC ACID INDUSTRY.*

By J. LAWRENCE SMITH.

Sulphuric Acid Saponification.

THIS method was discovered by Chevreul in his original researches on fatty bodies, and in the patent taken out by him in conjunction with Gay-Lussac in 1825, this method is specified, but certain portions of the fats were so altered as to discolour the product to such an extent as to render it of no use in practice. The acids, however, thus formed could be distilled more or less perfectly, as first shown by Chevreul, and subsequently practically executed by Dubrunfaut. But the first idea of combining the two operations, viz., sulphuric acid saponification followed by distillation, is due to Coley Jones and Wilson, of England, subsequently perfected by Gwinne and Jones.

The process as it is now carried out may be summed up as follows:—The fat is placed in large vessels that may be of wood or masonry lined with lead, and from six to fifteen per cent of concentrated sulphuric acid is added: the mixture is then heated by a steam coil to near the temperature of boiling water, and maintained at that temperature eighteen or twenty hours. Some, however, operate at a higher temperature, and consume less time in the reaction, with as much as thirty per cent of sulphuric acid and agitation, decomposing batches of two hundred pounds in four minutes. The fat is decomposed with an alteration of part of the glycerine and part of the fat, sulphurous acid and carbonic acid being evolved. The black mass resulting from the action of the sulphuric acid is now thoroughly washed by boiling water, until all the fatty acids are freed completely from sulphuric acid. The fatty acids are now introduced into large cast-iron stills, capable of holding over one ton of these acids. The stills are heated from below, so as to bring the contents to the temperature of 260° C., when a jet of superheated steam of 350° to 380° C. is made to traverse the charge, and in about twelve hours the matter is distilled over, leaving behind a pitchy substance, which may be used in the manufacture of gas, or for coating roofs and other purposes in the arts. The fatty acids when distilled may be cooled in pans, and submitted to the cold and hot pressure; for some purposes it is submitted only to the cold pressure, and in England much is used without any pressure at all; when palm oil has been the fat acted upon.

This method contrasted with the lime saponification has its advantages and disadvantages; among its advantages are the facility of using common and refuse fats, and in giving a larger yield of candle stuff; among its disadvantages are the inferior grade of candle stock produced, and the actual loss of about ten per cent of the fat by decomposition into gaseous and pitchy matters.

The comparative yield of lime and sulphuric acid saponifications in candle stock from tallow and palm oil is forty-seven per cent for the lime, and sixty-two per cent for the sulphuric acid.

Saponification by Water and Distillation.

The decomposition of fats by the increase of temperature and the subsequent distillation of the fat acids was originally observed by Chevreul, and different methods were devised by Moses Poole and by Gay-Lussac, as early as 1828, to obtain practical results from it, but so much acroleine was formed that it was abandoned as impracticable. Dubrunfaut revived the method, and was more successful; but it was reserved for George Wilson, of the Price Candle Works, near London, to solve the problem in 1852, at least so far as palm oil was concerned, and in 1855 he had three stills in operation, each of a capacity of about 1600 gallons, from which, by one and the same operation, the fat acids and glycerine were distilled over uncombined.

To accomplish this twofold result, viz., to accomplish the watery saponification of the neutral fats, and the distillation of the fatty acids and the glycerine that result from the saponification, it is necessary to heat the fat in a still to a temperature between 290° and 315° C., and to pass through the heated fat a current of superheated steam, properly subdivided, having a temperature of 315° C. For proper success in the operation, the distillation must be conducted between 290° and 315° C., as otherwise the distillation is very slow, or acroleine is produced. This distillation goes on slower than when the fatty acids already formed are acted upon, the latter being accomplished in one-half or one-third the time. The glycerine distilled is of a good quality, and admits of further purification, thus forming the widely known and much appreciated Price's glycerine. It is well to state here that the employment of other than palm oil in this process gives unsatisfactory results, and consequently its use is limited.

Saponification by Water Under High Pressure.

The conception of this method, in common with all the methods of saponification of fatty bodies, is to be referred back to the author of the discovery of the true nature of fats, M. Chevreul, for in his original researches he pointed out the perfect analogy between the fats and the compound ethers, the latter class of bodies being decomposed with their two constituents in the presence of water heated in close vessels under pressure; a reasonable deduction from which was that fats would undergo an analogous decomposition. This, however, was not undertaken at the time, but, by an accident, about the time of Chevreul's researches, it was first observed to take place by Faraday when his attention was drawn to some changes in oils used by Perkins in his curious steam-engine that employed very hot water. Faraday records the facts as observed by him in the *Quarterly Journal of Science, Literature, and the Arts*, published in London in 1823, vol. xvi., page 172, as follows:—

"*Change of Fats in Perkins's Engine by Water, Heat, and Pressure.*—Mr. Perkins uses in his steam cylinder a mixture of about equal parts of Russia tallow and olive oil to lubricate the piston and diminish friction. This mixture is consequently exposed to the action of steam at considerable pressure and temperature; being carried in by the steam it is found in the water, giving rise to peculiar appearances.

"The original mixture is solid at common temperature, but fuses at about 85° F. When boiled in alcohol a small portion dissolves. The water as it issues from the end of the ejection pipe into the tub placed to receive it and from which it is pumped up again into the generator, appears white and translucent, after having been used, it sometimes very much resembles thin milk. A scum is found floating on it, which, when collected together, forms a solid mass, but when it has been long exposed to the action of steam, and at a high temperature, it has very nearly the consistency of wax. It is always black and dirty.

"A portion of this substance was digested in hot alcohol and the clear solution set aside; floculi separated in abundance from it in cooling, which, when dried and collected and fused, gave a greyish substance, contracting and cracking as it cooled, with the lustre and appearance of wax, but rather more brittle. It does not melt in boil-

* From "The Progress and Condition of Several Departments of Industrial Chemistry," J. Lawrence Smith.

ing water, but at a higher temperature melts, and ultimately burns like wax. It is rather lighter than water; it dissolves readily in alkalies, more readily, I think, than fat, and in this respect resembles Chevreul's acids of fats as well as in its solubility in alcohol. The alkaline solution is turbid. It is not soluble in ether, or very slightly so; when burnt, it leaves an ash consisting principally of carbonate of lime. The cold alcoholic solution on evaporation left a substance similar in many respects, but much softer, even fluid. It burnt in the same manner, leaving a slight ash of carbonate of lime."

The above is sufficient to show that the practical decomposition of fats by water heated under pressure was accomplished as far back as 1823, as any chemist will conclude from Faraday's observation made at a time when we were much less endowed with facilities for research than we are now. No attempt was then made to draw any practical results from these observations, and we find no further notice taken of the subject until early in the year 1854, by R. A. Tilghmann, of Philadelphia, when patents were taken out by him for decomposing fats mixed with water and superheated in vessels of a certain description, the sum and substance of which method is embraced in the following portion of the specifications.

Tilghmann's Process.

He mixes the fat on which he operates with one-third or one-half its volume of water, and the mixture is placed in some convenient vessel in which it can be submitted to heat equal to that of melted lead, and kept at that temperature until the operation is complete. The vessel is to be closed so that the requisite pressure can be applied to prevent the water from being converted into steam. The result of the action is the splitting of the fat into fatty acids and glycerine, which can be readily separated, mechanically, and both prepared for market. The acids are cooled in the ordinary way and submitted to pressure to procure candle stuff.

The method of Tilghmann, as originally patented, was never introduced into practice; since then, with change in the manner of operating and in the nature of the boilers, it has been successfully conducted in many factories.

In the latter part of the same year that Tilghmann's process was patented, M. Melsens, of Belgium, took out a patent very analogous, using fats mixed with water in the proportion of twenty to one hundred per cent of the latter; the water might be acidulated with from one to ten per cent of sulphuric acid, or the addition of salt would suffice; the whole was heated from 180° to 200° C. for several hours. The success of Melsen's process was immediate, and it was put into operation on a large scale in Antwerp in vessels holding one ton of tallow, to which was added fifty per cent of water, and in six hours the decomposition was complete at a temperature of 180° C. (ten atmospheres). The fatty acids thus made were of a very satisfactory quality, quite as much so as those obtained by other methods of saponification.

PROCEEDINGS OF SOCIETIES.

ROYAL IRISH ACADEMY.

A GENERAL meeting of the members of the Royal Irish Academy was held on Monday evening, January 9th, 1871, the Rev. J. H. Jellet, President, in the chair. The attendance was not large.

New Members.—The following gentlemen were, after a ballot, elected members of the Academy:—Very Rev. Ulick J. Bourke, Tuam; George Woods Maunsell, Esq.; John Symons, Esq., Hull; and Ramsay H. Traquair, Esq., M.D.

Mr. CHARLES R. C. TICHBORNE, F.C.S., read two short papers, entitled "*Laboratory Notes.*" The first was on "*The Production of Acetic Acid by the Destructive Distillation of Resin.*" He said he found that, when resin was submitted to distillation, among other products was a strongly acid solution. The silver salt of this acid was formed, and on analysis it proved to be acetic. He remarked that it was rather surprising to see acetic acid produced in appreciable quantities from a substance so comparatively pure in oxygen. The amount of oxygen in colophony was 10·6 per cent, whilst in an acid-yielding substance, such as woody fibre, it was 49·4 per cent.

The subject of the second paper was "*The Formation of Ozone by Resin Oils.*" He said when light resin oils were submitted to the combined action of atmospheric oxygen and light, ozone was produced in abundance. ("Such oils, when poured upon a solution of iodide of potassium, instantly produce blue iodide of starch.") At the same time the boiling-point of the oil was raised. Ozone was probably the prime mover in the production of colophonic hydrate, a substance discovered about two years ago by himself. All the terebine oils on exposure to light produced this effect. That obtained from pine seeds was said to possess this property in a most marked manner; oils of lemon and bergamot in a slight degree. The resin oils possessed this property more decidedly than ordinary oil of turpentine. Mr. Tichborne, by experiments, showed the action of those ozonified oils upon iodide of potassium.

The papers were referred to the council for publication.

Mr. G. J. STONEY, F.R.S., next read an exhaustive paper "*On the Cause of Interrupted Spectra of Gases.*" This paper was also ordered to be printed.

ROYAL GEOLOGICAL SOCIETY OF IRELAND.

A GENERAL meeting of this Society was held on Wednesday, in the Museum Building, Trinity College. The chair was taken by the Rev. Maxwell Close, and the following papers were read:—

(1.) EDWARD HULL, Esq., F.G.S.—"*On the Geological Age of the Ballycastle Coal-field, and its Relations to the Carboniferous Rocks of the West of Scotland.*"

(2.) JOHN LEECH, Esq.—"*On the Moving Bog of Castlerea, Co. Roscommon.*"

NOTICES OF BOOKS.

Handy Book of Small Farm Management. By THOMAS BALDWIN, Superintendent of the Agricultural Department of National Education (Ireland). Dublin: Browne and Nolan.

THIS volume, dedicated to his Excellency the Viceroy of Ireland, Earl Spencer, K.G., &c., is a book which, although it is evidently written with special reference to the Emerald Isle, contains in 215 pages an exceedingly large amount of well-digested matter, interesting to all farmers, too many of whom are not so conversant with the subjects herein treated of as they ought to be. The main divisions of this work are:—Manures; Farm Implements; Crops; Live Stock; Works which Permanently Improve the Value of Land; the Management of a Five-and-a-half Acre Farm at Glasnevin. We have perused this little book with great pleasure; the author is a thorough master of his subject, and he is very successful in writing what he has to say in plain, clear, and intelligible language. We hope that all who take an interest in that unfortunate, although beautiful, portion of the British Dominions—Ireland—will contribute to disseminate the contents of this little book among the many small farmers of that island. We also recommend the perusal and study of this small work

to English farmers, who will find, even in the wood-engravings alone, many a useful hint worthy to be impressed on their mind and retained in their memory.

Handbook of the Telegraph; being a Manual of Telegraphy, Telegraph Clerk's Remembrancer, and Guide to Candidates for Employment in the Telegraph Service. By R. BOND. Third edition, revised and enlarged, with illustrations. London: Lockwood and Co., 1870.

THIS neat little volume, No. 138 of Weale's Rudimentary Series, contains the following chapters:—Introduction; Form of Application, Security, Secrecy, &c.; Officials; Scale of Charges; Delivery of Telegrams; the Double Needle Instrument; the Single Needle Instrument; the Morse Printing Instrument; Grouping of Letters of Different Alphabets; Hughes's Printing Instrument; the Bell Instrument; Wheatstone's Automatic System; Wheatstone's A B C Instrument; the Pneumatic Tube; Postal Telegraph Codes; Miscellaneous Regulations; Inland Telegrams; Forms; Miscellaneous Regulations; Abstracts, Abstract Books, Accounts, Returns; Railway Companies' Messages and Forms; Railway Train Telegraph; Offences; Useful Hints; Telegraph Statistics; Index. From this list our readers will perceive that the volume has been prepared especially with the view of being a guide to those who desire to enter the telegraph service, and for this purpose the work is very well adapted, being clearly, yet concisely written, and well illustrated by woodcuts. The fact that this little volume has already reached a third edition is the best evidence of its utility.

Abstracts of English and Colonial Patent Specifications Relating to the Preservation of Food, &c. Compiled from original documents, or their printed copies, lodged in the Patent Office attached to the Registrar-General's Department, Melbourne, by WILLIAM HENRY ARCHER, Registrar-General of Victoria. Melbourne: Printed and published by John Ferres, Government Printer; also published by H. T. Dwight, 232, Bourke Street East, 1870.

THIS pamphlet contains, compressed into the space of sixty-six pages, an unusually large amount of highly valuable matter. After a brief preface, the author, in an introductory chapter, sets forth the scientific principles of fermentation and putrefaction, and next treats briefly on the following subjects, under the headings of each of which respectively the abstracts of the patents have been classified, viz:—Reduction of Temperature; Deprivation of Moisture; Salting; Exclusion of Air; Antiseptic Agents. The contents of this pamphlet are too numerous to admit of any particular abstraction or quotation. The work is illustrated by a series of exceedingly well executed photo-lithographic plates, and is in this respect a decided improvement over several similar publications issued by our own Patent Office. All who are interested in the preservation of food and the numerous means devised to gain that end, will peruse this pamphlet with pleasure.

CORRESPONDENCE.

FUSIBILITY OF PLATINUM BY THE BLOWPIPE.

To the Editor of the Chemical News.

SIR,—Your issue of the 3rd ult. (CHEMICAL NEWS, vol. xxiii., p. 268) contains a communication from Dr. W. Skey, of New Zealand, which opens with the following sentence:—

"The metal platinum has hitherto been supposed to be infusible, except at a temperature that is so high as to be incapable of being produced by the common blowpipe; at least, I have carefully searched for any statements to the contrary, without success."

If Dr. Skey will look in Plattner's "Probirkunst," p. 16 of last edition (p. 14 of 3rd edition), he will find the following statement:—

"When it is desired to test whether it is possible to produce a sufficiently strong oxidising flame, it is only required to try to fuse the end of a platinum wire of a thickness of 0·1 m.m. to a globule. The wire is bent for this purpose at a right angle, and the shorter bend is so held in the outer flame that the axis of the wire exactly coincides with the axis of the blowpipe-flame, care being at the same time taken that neither wire nor flame vibrate. With strong and really good flame a globule of molten platinum is very soon formed, and this globule will be the larger according to the greater strength of the flame."

A similar method of showing the fusibility of platinum by the blowpipe is given by Dr. H. O. Lenz, in his "Löthrohrschule" (Gotha, 1848); and Bruno Kerl, in his handy little "Lietfaden," refers also to the fusibility of fine platinum wire by the blowpipe-flame. Other published statements of this well-known fact might likewise be quoted.—I am, &c.,

E. J. CHAPMAN.

Toronto, Canada,
December 26th, 1870.

ANTISEPTICS AND DISINFECTANTS.

To the Editor of the Chemical News.

SIR,—My friend Professor Gamgee, in a letter published in the last number of your journal (CHEMICAL NEWS, vol. xxiii., p. 20), "protests against Dr. Crace Calvert's system of experimenting on the comparative energy of antiseptics," and especially as regards the solution of chloride of aluminium. I do not write now to defend Dr. C. Calvert, but on my own account, to protest against Professor Gamgee's assertion as to carbolic acid, and to recommend caution in accepting "chloralum" as a *disinfectant*.

(1.) He says, "Two years experience with carbolic acid has proved that as a sick room disinfectant, and even in open alleys and stables, people refuse to use it," inferentially on account of its odour. He is in error here. I commenced the extensive use of carbolic acid for the purposes of "disinfection" at the time of the cattle plague, in 1865; I used it as my sole disinfectant very largely, and for all purposes—*i.e.*, for closets, drains, rooms, bedding, clothing, &c., during the cholera epidemic of 1866. I have used it since then constantly and habitually for similar purposes where fever, scarlet fever, and small-pox have prevailed, and I can assert positively that, when used thoroughly and every detail is attended to as it should be, it is a most efficient agent for destroying contagia. Moreover, my experience is that people do not refuse to use it except when the crude acid employed smells of sulphide of ammonium. That supplied by some manufacturers is very objectionable on this account, and I have refused to purchase such acid for the public service here, because people would certainly have rebelled. McDougall's acid is quite free from objection on this score; we use it for night-stools and similar utensils, and for floors in the sick room, and for evaporation there constantly. During the past dry summer I used it in the water-carts upon the roadway in our narrow streets, courts, and alleys, with positive satisfaction to the inhabitants; they said it "sweetened the air"—and it did. In empty rooms I prefer to fumigate with sulphurous acid.

(2.) I object to the inference that, because "chloralum" is an antiseptic, it is necessarily a disinfectant; and I protest against Professor Gamgee assuming its disinfecting power from its chemical properties as an antiseptic. The term "disinfection" has of late acquired greater precision of signification than it had a few years

ago. It means the destruction of the vitality—power of growth and reproduction—of those minute particles of matter which, given off from the sick, are capable of producing a like disease in the healthy. To prove anything to be a disinfectant, one or both of the following kinds of evidence must be forthcoming:—(1). It should be shown by *experiment* conducted by some such accomplished microscopist as Dr. Beale or Dr. Sanderson, that the substance in question, used in the strength at which it is proposed to use it as a disinfectant, has the power of destroying the vital manifestations of those minute amœbiform particles of matter which constitute the simplest form of living things. I can scarcely imagine a better service that could be rendered just now to preventive medicine than the publication of some reliable observations of this kind in respect of the reputed disinfectants. They would make a grand clearance of our foggy notions about disinfectants. (2). It should be shown on a large scale, and by repeated and prolonged observation, that the use of the reputed disinfectant actually has resulted in the arrest of the spread of contagious disease. Such observations are best made first upon the contagious diseases of animals. Positive inferences drawn from such observation should be capable of resisting fair logical criticism. I have the greatest personal respect for Professor Gamgee, and for the admirable work he has done—no one more; and I do not believe he would claim "disinfecting" powers for chloralum unless he was himself satisfied that it possessed them; but the proof which may be convincing to him may nevertheless be insufficient to establish his claim in a way satisfactory to others. He will, I am sure, pardon me for saying that, in my view of the matter, he is not warranted in propounding chloralum as a "disinfectant," and still less in recommending its use as such, without, at the same time, adducing the evidence on which his opinion and recommendation are grounded. The *onus probandi* lies with him: he cannot make the assertion, and then leave the profession to show that he is wrong, although there are plenty of bad precedents for such a course.

"Chloralum" may turn out to be the best disinfectant known; his discovery may possibly be one of the highest practical value, but he cannot be permitted to anticipate observation and experiment. He has as yet advanced nothing to satisfy me, or any one, that chloralum used in any way is capable of destroying the peculiar manifestations of a morbid contagion. That it is capable of checking the throat lesions in diphtheria and scarlatina is no more than has been said by the highest authorities of ordinary alum. That medical men should have taken it up with extraordinary rapidity goes for very little, since nothing can be more wild than the manner in which medical men often adopt this or that favourite or reputed disinfectant; and, moreover, Professor Gamgee himself tells us that one great secret of its success has been its freedom from odour. May it not be possible to retort, in the words he uses when speaking of Condy's fluid, which he says "has been supposed to act like carbolic acid, and to disinfect, physicians prescribing it gladly in the erroneous belief that it added to its deodorising properties that of destroying disease germs. Its success has been due to its freedom from odour."

One word more, and I have done. Professor Gamgee has asked me to use the chloralum, and has kindly supplied me with a quantity for this purpose. Small-pox and scarlet fever are now raging in my district, and thus I have abundant opportunities of doing so. Why, then, have I not tried it? This is a fair question to ask, and I will anticipate it. My reply is that I dare not assume the responsibility of its trial until *primâ facie* proof at least is afforded me that by using it I shall be using that which is capable of "destroying disease germs." I must have something which I can rely upon. I can rely upon the disinfectant agencies I employ now, the reliance depending upon empirical observation; I cannot rely upon chloralum, for neither experimental nor empirical observation has been produced in its support.—I am, &c.,

EDWARD BALLARD, M.D.,
Medical Officer of Health for Islington.

7, Compton Terrace, N.,
January 13th, 1871.

MISCELLANEOUS.

Royal Institution of Great Britain.—We have received a corrected list of the arrangements for the Friday Evening Meetings before Easter, from which we learn that the subject of the discourse by Dr. Odling on Friday, January 27th, will be "Recent Improvements in the Production of Chlorine." The discourse on Friday, February 24th, will be by W. Mattieu Williams "On Rumford's Scientific Discoveries," and Dr. Carpenter's discourse on "The Latest Scientific Researches in the Mediterranean and Straits of Gibraltar," will be delivered on March 10th, instead of February 24th, as announced in our last week's issue.

Metropolitan Gas Supply.—Dr. Letheby, the Chief Gas Examiner appointed by the Board of Trade, has recently submitted to the Corporation and the Metropolitan Board of Works a report of the quality of the gas supplied to London by several of the gas companies during the last three months, and the following are the tabular results:—

1st. With regard to Illuminating Power—

Illuminating Power in Standard Sperm Candles.

			Maximum.	Minimum.	Average.
Common gas.	City of London Gas Company		18·4	16·2	17·20
	Chartered Gas Co.	Leadenhall St. ..	19·2	16·5	17·57
		Gray's Inn Road	17·5	15·5	16·50
		Arundell Street ..	18·7	16·4	17·37
	Great Central Gas Company		19·3	16·6	18·02
	Imperial Gas Co.	Camden Street ..	17·1	14·1	15·49
		Oakley Square ..	17·8	15·2	16·50
	South Metropolitan Gas Co...		18·5	14·2	16·14
Cannel gas.	City of London Gas Company		30·8	24·3	26·96
	Chartered Gas Company ..		26·6	23·1	25·55

From which it appears that the average illuminating power of the common gas supplied by the several companies has ranged from 15·49 candles, in the case of the Imperial gas, at the Camden Street testing place, to 18·02 in that of the Great Central gas; and the Cannel gas has been from 25·5 to 26·9 candles.

2nd. With respect to Purity.—The gas of all the companies has been constantly free from sulphuretted hydrogen, but the amount of sulphur in other form has fluctuated to a large extent, as will be seen from the following table:—

Grains of Sulphur per 100 cubic feet.

			Maximum.	Minimum.	Average.
Common gas.	City of London Gas Company		30·3	17·8	23·54
	Chartered Gas Co.	Leadenhall St...	34·8	19·5	27·25
		Gray's Inn Road	36·9	21·9	33·17
		Arundell Street..	33·8	22·7	28·02
	Great Central Gas Company		31·1	11·1	19·78
	Imperial Gas Co.	Camden Street ..	31·8	23·4	27·91
		Oakley Square ..	38·4	27·0	32·37
	South Metropolitan Gas Co...		39·3	27·6	32·31
	City of London Gas Company		22·4	4·8	12·27
	Chartered Gas Company ..		27·9	19·7	24·39

So that, in the case of the common gas, the average proportion of sulphur has been from 19·78 grains per 100 cubic feet, in the Great Central gas, to 33·17 grains in that of the Chartered gas at Arundell Street; and the Cannel gas has ranged from 12·27 grs. per 100 cubic feet of the City companies' gas to 24·39 in the Chartered.

Ammonia has rarely been present in excessive quantity; but it exceeded 5 grs. per 100 cubic feet on five occasions in the Imperial Company's gas, at the testing place at Oakley Square, Chelsea, and on one occasion in the Chartered gas at Arundell Street; both of these were subjects of appeal to Dr. Letheby, who decided, after full enquiry into the matter, that the excess arose from accidental circumstances.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Polytechnisches Journal von Dingler, first number for December, 1870.

This number contains the following original papers relating to chemistry and allied sciences:—

Determination of the Value of Various Kinds of Kaolin by means of a Pyrometrical Method.—Dr. C. Bischof.—The author describes, in this exhaustive paper, a series of experiments made with porcelain clay obtained from different localities, the standard sample being the levigated porcelain clay from Zettlitz, near Carlsbad (Bohemia), which consists, in 100 parts, of—Alumina, 38·54; chemically-combined silica, 40·53; silica as sand, 5·15; magnesia, 0·38; lime, 0·08; peroxide of iron, 0·90; potassa, 0·66; loss by ignition, 13·0. This sample, pressed into the shape of small cylinders, was first heated to the temperature of the melting-point of platinum by itself, and the effect of this ignition carefully examined, and the experiment repeated with the addition of a flux from 1-10th to 2-10ths of the weight of the kaolin. In this manner have been tested—The kaolin from Halle; kaolin from Aue; kaolin from Seilitz, near Meiszen; kaolin from Sornzig; kaolin from St. Yrieix; kaolin des Colettes près Calizolle (Algeria); kaolin from Brittany; kaolin from Pilsen; kaolin from St. Austell.

New Method for the Quantitative Estimation of Copper by Volumetry.—F. Weil.—Reserved for full translation.

Researches on the Part which Saline Substances and Non-Crystallisable Sugar Play in the Formation of Molasses.—E. Feltz.—The author, manager of an extensive beet-root sugar manufactory, relates a series of experiments made with the view of elucidating the mode of action of non-crystallisable sugar upon the formation of molasses—that is to say, the conversion, by the presence of the substances alluded to, of crystallisable into non-crystallisable sugar.

Use of Centrifugal Machines for the Purpose of Obtaining Raw Sugar.—Dr. O. Tech.

Charcoal as a Disinfectant and Antidote.—Drs. H. Eulenberg and H. Vohl.—This exhaustive memoir contains the account of a series of experiments made with the view of investigating the disinfectant, deodorising, and antidote properties of charcoal, bone-black, and similar materials.

Compressed Leather.—Dr. Dingler.—The author states that offal of leather, cuttings, and scraps, are first cleansed from dirt and dust, then soaked in water containing 1 per cent of sulphuric acid, until the material becomes soft and plastic, next compressed into the shape of blocks, dried by steam, and lastly rolled out in mills. In order to soften the mass, 1 lb. of glycerine is added to 100 lbs. of material. The leather thus again obtained is applicable for the inner soles of boots, &c.

Annalen der Physik und Chemie, von Poggendorff, No. 11, 1870.

This number contains the following original memoirs and papers:—

New Optical Method of Determining the Vibrations of Columns of Air which Emit Sound.—Drs. Tœpler and Boltzmann.—This lengthy essay, illustrated by a series of lithographic plates, contains the account of experiments belonging to the subject of acoustics.

Temperature and Physical Constitution of the Sun.—F. Zöllner.—This essay, illustrated by a series of very beautifully executed chromo-lithographs, is, as regards its contents, entirely of an algebraical character. The author deduces, however, from his investigations the following condensed results:—(1). The absence of the lines of some element in the spectrum of a self-luminous body (star) does not prove the absence of this substance. (2). The layer in which the inversion of the spectrum takes place differs for every body, and that layer is placed the nearer to the centre of the star according to the greater vapour density and emissive power of the substance which yields the spectrum. (3). This layer is, *ceteris paribus*, nearer to the centre of different stars according as the intensity of the gravitation thereof is greater. (4). The distances of the layers of conversion of the simple bodies (emitting spectra) from each other, as well as from the centre of the stars, increase with an increase of temperature. (5). The spectra of different stars are, *ceteris paribus*, the richer in spectrum lines according to the lower temperature and the greater mass of the stars. (6). The great difference observed in the intensity of the dark lines of the solar spectrum and that of other fixed stars does not simply depend upon the difference of the power of absorption, but also upon the difference of depth wherein the inversion of the respective spectra takes place.

Transversal Vibrations of Sound-Emitting Liquids and Elastic Fluids.—Dr. L. Matthiessen.—A mathematical essay.

Attraction Exercised by a Magnetising Spiral upon a Movable Iron Cylinder contained Inside the Spiral.—Dr. A. von Waltenhofen.—A memoir illustrated by a series of diagrams and engravings absolutely required for it to be properly understood.

On Disaggregation, and on the True Caloric Capacity of Bodies.—Dr. E. Budde.

Observations on Amorphous Sulphur.—R. Weber.—This essay contains the account of a series of experiments made with sulphur obtained by precipitation (by means of acids) from hyposulphites, alkaline sulphurets, and the decomposition of sulphuretted hydrogen. Sulphur obtained from hyposulphite of soda by the addition of some hydrochloric acid to the solution of that salt, exhibits the appearance of an oily fluid, which remains liquid for a considerable time after having been washed by carefully-conducted decantation, and resembles, as regards colour and consistency, the yolk of eggs. The sp. gr. of this sulphur varies from 1·92 to 1·927; it is amorphous, but becomes, when completely solidified, crystalline, a phenomenon which is greatly accelerated by heat. The author found that the liquid sulphur contains small quantities of persulphide of hydrogen, but the origin of that substance could not be traced. The assertion often made, that crystalline sulphur by contact with acids is converted into amorphous sulphur, is not found to be correct when experiments were purposely instituted to test this.

New Locality where Meneghinite is Found.—A. Frenzel.—The author describes a locality in Germany where the mineral alluded to has been found by him. The mineral, on being examined, was found to possess a sp. gr. of 6·367. The chief constituents of this substance are lead, antimony, and sulphur; in 100 parts—Lead, 63·89; antimony, 18·82; sulphur, 17·29.

Galvanic Caloric Action (Wärmewirgung) at the Limit of the Surface of Electrolytes.—C. Schultz-Sellack.

Two Optical Methods of Observation.—C. Christiansen.—Algebraico-physical papers.

Observations on Kohlrausch's Experiments for the Determination of the Capacity of Heat of Gases.—L. Boltzmann.

A Pseudoscopic and Optometric Figure.—H. Emsmann.

Co-Efficient of Refraction of an Alcoholic Solution of Fuchsine.—C. Christiansen.—A series of tables.

Journal für Praktische Chemie, No. 18, 1870.

This number contains the following original papers:—

Presence of Amygdaline and a New Asparagine-Like Substance in Vetch (Vicia sativa).—H. Ritthausen and Dr. U. Kreusler.—The authors, while experimenting with vetch obtained from Attica (Greece), found, on treating the coarse powder of this seed with water, that it gave off the smell of hydrocyanic acid, which, on nearer investigation, was found to be due to an amorphous modification of amygdaline. As regards the presence of an asparagine-like substance, the authors found a crystalline body, which, on being submitted to elementary organic analysis, gave results leading to the formula, $C_8H_{16}N_2O_6$; this substance is difficultly soluble in water, more readily so in boiling dilute alcohol, and almost insoluble in boiling alcohol at 85 per cent.

Acids contained in the Seeds of Yellow Lupines (Lupinus Luteus).—H. Ritthausen.—This memoir contains an exhaustive account of the qualitative and quantitative methods of analysis employed by the author to detect and determine, in the seeds of the plant just named, malic and oxalic acids, present in the state of combination with bases.

Some Inorganic Periodides.—Dr. S. M. Jörgensen.—The following periodides are described:—Potassium-triodide: The aqueous solution of this salt is discoloured when shaken up with some mercury, the result being the formation of some proto-iodide of mercury; the alcoholic solution of the potassium-triodide is also decolourised when so treated, but no iodide of mercury is eliminated. Cupro-tetrammonium-mercuro-iodide, $4NH_3,CuI_2,2HgI_2$: In 100 parts—Ammonium, 5·26; copper, 4·91; mercury, 30·92; iodine, 58 91. Cupro-tetrammonium tetra-iodide, $4NH_3,CuI_2,I_2$. Cupro-tetrammonium mercuro-iodide, $4NH_3,CuI_2,HgI_2$. Cupro-tetrammonium hexaiodide, $4NH_3,CuI_2,I_4$. Mercuro hexaiodide.

Composition of Plumbostibe and of Embrithite.—A. Frenzel.—After referring to some older analysis of these minerals, the author states that, on making accurate estimations of the constituents, he found for plumbostibe, in 100 parts:—Lead, 60·59; antimony, 21·53; sulphur, 17·88. Sp. gr. of the mineral, 6·12. The formula of embrithite is exactly the same as that just mentioned, but the mineral was

found to contain, in 100 parts:—Lead, 59·30; copper, 0·80; antimony, 21·47; sulphur, 18·08;—total, 99·65.

Quantitative Estimation of Phosphorus present in Pig-Iron, Steel, and Wrought-Iron.—F. Kessler.—This lengthy memoir contains the account of a series of experiments instituted by the author with the view to test a method of estimation of phosphorus in the metals alluded to, whereby the metals, after having been dissolved in suitable acids, are completely precipitated by ferrocyanide of potassium, and the phosphorus estimated in the filtrate as pyrophosphate of magnesium. The author has compared this mode of operation with that of the molybdic acid method, and the results are reported to be in favour of the ferrocyanide of potassium plan.

NOTES AND QUERIES.

Solubility of Tin in Nitric Acid.—The solubility of tin in cold dilute nitric acid has long been known. Probably, the colder the acid the less water is needed. If Mr. Hay refers to Gmelin's "Chemistry" (Cavendish Society's edition), vol. v., p. 92, he will find it stated that "very dilute nitric acid, at ordinary temperatures, dissolves tin."—R. W.

Solubility of Tin in Nitric Acid.—Mr. Hay will find an account of the production of stannous nitrate by the solution of metallic tin in dilute nitric acid in Watts's "Dictionary," vol. iv., p. 107. I may also state that a solution of tin in dilute nitric acid has been used by dyers as a mordant in the West Riding of Yorkshire during the last forty years.—GEO. JARMAIN, 80, Northgate, Huddersfield.

Solubility of Tin in Nitric Acid.—Among my lecture-notes which I have been using during the last six years, I find this statement:—"Tin, antimony, and tungsten, when heated with the moderately-strong acid, are converted into insoluble oxides; the others, and tin also when diluted acid is taken, are converted into nitrates, all of which are soluble." Of course, only such metals as are acted on by nitric acid are referred to. Never having myself experimented on the subject, this statement regarding the tin must have been published at the time, six years ago, and must, moreover, have already been a recognised fact. Where the original statement is to be found I do not now remember, but that it is to be found there can be no doubt whatever.—A. DUPRE, Laboratory, Westminster Hospital, London, S.W.

Solubility of Tin in Nitric Acid.—In your impression of the 16th ult. (CHEMICAL NEWS, vol. xxii., p. 298) Mr. George Hay describes the solvent powers of nitric acid upon tin, dissolving the metal, and forming a yellow solution which is decomposed at the boiling-point, forming the hydrate of meta-stannic acid. In "Notes and Queries" of your impression of the 13th inst., he asks if the fact of the solubility of tin in nitric acid has been published previously to his announcement alluded to above. If he will kindly refer to Brande's "Manual of Chemistry," 1848, p. 783, he will find the solublility announced under the head of "protonitrate of tin." This, says Brande, "may be formed by acting upon the *metal* by dilute nitric acid. . . . . A yellow solution which will not crystallise is obtained; exposed to the air, it absorbs oxygen and peroxide of tin precipitates, or, according to Dumas, a hydrate of the protoxide. If evaporated, the oxide falls, and a portion of nitrate of ammonia remains. During the action of the dilute acid upon tin no gas is evolved; it is therefore evident that water, as well as part of the acid, are in this case decomposed." For the benefit of the student reader, I have not appended the formula of the decomposition from Brande, but have translated it into a modern formula:—$8Sn + 20NO_2HO = 8N_2O_4Sno'' + NO_3Amo + 6OH_2$. Ammonium nitrate being formed simultaneously, as might be expected (Does not Mr. H. B. Gibbins mean the above, and not "evolution of ammonia," in presence of an excess of acid?). I hope this information will suit Mr. G. Hay, as the *yellow liquid* is probably identical with his, seeing that on page 784 Brande says that, by treating the metal with concentrated acid, none remains in solution.—GEORGE E. DAVIS, Eton.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 23rd.—Medical, 8.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology. (Educational Course.)
—— Royal Geographical, 8.30.
TUESDAY, 24th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Ethnological, 8.
—— Civil Engineers, 8.
WEDNESDAY, 25th.—Society of Arts, 8.
—— Geological, 8.
—— London Institution, 7. Conversazione. Prof. Tyndall, LL.D., F.R.S., "On Dust and Disease."
THURSDAY, 26th.—London Institution, 7.30. Mr. F. S. Barff, M.A., F.C.S., "On the Action, Nature, and Detection of Poisons."
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Royal, 8.30.
FRIDAY, 27th.—Royal Institution, 9. Dr. Odling, "On Recent Improvements in the Production of Chlorine."
—— Quekett Microscopical Club, 8.
SATURDAY, 28th.—Royal Institution, 3. Rev. W. H. Channing, "On Laws of Life Revealed in History."

TO CORRESPONDENTS.

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ERRATA.—In Mr. Highton's letter of last week the following sentence should have been omitted:—"And again, in Mr. Bottomley's problem, though he gets most intensity by his arrangement, he does not get most heat."

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THE CHEMICAL NEWS.

VOL. XXIII. No. 583.

SOME EXPERIMENTS ON THE DISCHARGE OF ELECTRICITY THROUGH RAREFIED MEDIA AND THE ATMOSPHERE.*

By CROMWELL FLEETWOOD VARLEY.

THE nature of the action inside the tube is at present involved in considerable mystery, but some light is thrown upon the subject by the following experiments.

The tube principally used in these experiments contains two aluminium wire rings, the one $\frac{4}{10}$th inch in diameter, the other $\frac{5}{10}$th inch, and separated $\frac{4}{10}$th inch, the tube 1¼ inch in diameter, 3¼ inches in length; it was one of Geissler's manufacture, was very well exhausted, and professed to contain hydrogen. A U-shaped glass tube containing glycerine and water was placed in circuit. Two aluminium wires inserted in this tube gave a ready means of reducing or augmenting the resistance at pleasure. Glycerine affords an easy means of producing very great resistances.

The battery used in this experiment was a Daniell's battery, each cell having a resistance of from 50 to 100 Ohms. The resistance of the glycerine-and-water tube was between 2 and 3 megohms; this latter resistance was made large, in order that the resistance of the tube and battery might be neglected without entailing error.

The following law was found to govern the passage of the current:—1st. Each tube requires a certain potential to leap across. 2nd. That having once established a passage for the current, a lower potential is sufficient to continue the current. 3rd. If the minimum potential, which will maintain a current through the tube, be P, and the power be varied to P+1, P+2, &c. to P+n, the current will vary in strength, as 1, 2, &c., n.

It appears that a certain amount of power is necessary to spring across the vacuum; after that it behaves as an ordinary conductor, excluding that portion of the battery whose potential is P, and which is used to balance the opposition of the tube. In these experiments P was 304 cells. The tube in question could not be persuaded to allow a current of less than 323 cells to pass; but when once the current had established a channel, on lowering the potential by *short circuiting* portions of the battery, so as not so break the circuit, the current would flow when the battery was reduced to 308 cells.

Nature of the Luminous Cloud.—Plücker has shown that when such an exhausted tube, with a current through it, is placed between the poles of an electro-magnet, a luminous arch is produced, which arch follows the course of the magnetic rays.

As the electro-magnet is magnetised, the tube, which before was full of a luminous cloud, is seen gradually to change; the magnet gathers up this diffused cloud, and builds up the arch.

Inasmuch as the electricity was passing in a continuous current from the battery, from wire to wire, it is evident the light is projected right and left into those parts of the tube where there is no electric current flowing.

To endeavour to ascertain the nature of this arch, a special tube was constructed. A piece of talc, bent into the form U, had a fibre of silk stretched across it; on this fibre of silk was cemented a thin strip of talc, 1 inch in length, $\frac{1}{10}$th inch broad, weighing about $\frac{1}{10}$th of a grain. The tube was sealed up and exhausted; carbonic acid and potash were used to get a high vacuum. When the magnet was not magnetised, the passage of the current from wire to wire did not affect the piece of talc. When the magnet was charged, and the luminous arch was made to play upon the lower portion of the talc, it repelled it, no matter which way the electric current was passing.

When the tube was shifted over the poles of the magnet so as to project the luminous arch against the upper part of the talc, the upper end of the talc was repelled in all instances; the arch, when projected against the lower part of the talc, being near the magnet, was more concentrated, and the angle of deviation of the talc was as much as 20°. When the upper part of the arch, which was much more diffused, was thrown upon the upper part of the talc, it was repelled about 5°.

This experiment, I think, indicates that this arch is composed of *attenuated particles of matter projected* from the negative pole by electricity in all directions, but that the magnet controls their course, and these particles seem to be thrown by momentum on each side of the negative pole, beyond the limit of the electric current.

This arch requires time for its formation, for when a charged condenser is discharged through the tube no arch is produced. The arch from the negative pole is a hollow cylinder; the little talc tell-tale against which the arch was projected cut out the light, and a corresponding dark space existed throughout the remainder of the course of the arch.

There was on the talc, at the spot where the arch struck it, a little bright luminous cloud, as though the attenuated luminous vapour was condensed by this material obstruction.

Great care had been taken not to let the arch strike the single filament of silk which suspended the talc. Having demonstrated that the talc was repelled as described, the arch was allowed to play against the silk fibre, which the author expected would have been instantly burnt; such, however, was not the case. Even when a powerful induction-coil replaced the battery, the fibre remained unhurt.

Comparison of the above Phenomena with Discharges between the Poles of a Holtz's Machine in air.

In the first part of this paper four different kinds of discharges were described *in vacuo*. With a "Holtz's" machine, which will give 11-inch sparks in the air, four well-marked different kinds of discharge have been obtained *in the air*; one of which, the author thinks, will explain the curious and rare phenomenon known as "ball lightning."

In the experiments hereafter referred to, the condensers were, in all cases, attached to the "Holtz's" machine. The first discharge is the long 11-inch zigzag spark or lightning-flash; the second is the well-known "brush," which is best obtained by connecting the negative pole of the "Holtz's" machine to the earth; the third kind of discharge is a hissing red flame, ½ inch in length, playing about the negative pole, the positive pole being scarcely luminous at all, and if luminous, at one or two points only; the fourth or most remarkable phenomenon is best obtained in the following manner (I should here remark that the brass balls on each of the poles are about an inch in diameter):—Tie to the negative pole a small thin strip or filament of wood, 3 inches in length, and bent so as to project on each side of the negative pole, and a little beyond it towards the positive. On rotating the machine, two bright spots are seen upon the positive pole. If the positive pole be made to rotate upon its axis, the luminous spots do not rotate with it; if, however, the *negative pole*, with its filament of wood, be rotated, the spots on the *positive pole obey it*, and rotate also. The insertion of a non-conductor, such as a strip of glass, in front of the projecting wooden end, obliterates the luminous spot on the positive pole. When the author first discovered this, he, seeing apparently pieces of dirt on the positive pole, wiped it clean with a silk handkerchief, but there they remained in spite of all wiping; he then examined the negative pole, and discovered a minute speck of dirt corresponding to the luminous spots on the positive pole.

* Abstract of a paper read before the Royal Society.

When the filament of wood is removed from the negative pole, there is sometimes a luminosity or glow over a large portion of the surface of the positive ball. If in this state three or four little pieces of wax, or even a drop or two of water, be placed upon the negative pole, corresponding non-luminous spots will be found upon the positive pole, which rotate with the former, but do not with the latter.

It is, therefore, evident that there are lines of force existing between the two poles, and by these means one is able to telegraph *from* the negative *to* the positive pole to a distance of 8 inches through the air, without any other conductor than that which the electrical machine has constructed for itself across the non-conducting gas.

The foregoing seems to the author to give a possible explanation of "ball-lightning;" if it be possible for there to be a negatively electrified cloud sufficiently charged to produce a flash from the earth to the cloud, a point in the cloud would correspond to the wood projection on the negative conductor; if such a cloud exist, a luminous spot would be seen moving about the surface of the earth, corresponding to the moving point of cloud over it, and thus present phenomena similar to those described by the privileged few who have witnessed this extraordinary natural phenomenon.

The author has been informed more than once by captains of vessels, that when men have been struck by lightning, a slight burn has been left upon the skin of the same shape as the object from which the discharge flew. In one instance he was informed that some brass numbers, attached to the rigging from which the discharge passed to the sailor, were imprinted upon his skin.

It is now seen that this is perfectly possible if the discharge be a negative one, that is, if the man be + to the brass number.

A TABLE FOR CALCULATING THE WEIGHT AND YIELD, PER RUNNING FATHOM, OF MINERAL VEINS.

By E. J. CHAPMAN, Ph.D.,
Professor of Mineralogy and Geology in University College, Toronto, and Consulting Mining Engineer.

THE weight in tons and average richness of mineral veins are usually given per running fathom—that is, per parallelogram measuring 6 feet in length, and 6 feet in depth, by the mean width of the vein, whatever the latter may be. The following table will enable these results to be calculated very rapidly, provided the specific gravity of the vein matter (mixed ore and gangue), and the average percentage of metal or mineral carried by the vein, be previously ascertained. The table has been calculated on the supposition that the specific gravity equals unity, and that the average yield in metal is equivalent to 1 per cent. The values given in columns III. and IV. must thus be multiplied by the specific gravity of the vein matter; and those given in column V. must be multiplied also by this quantity, and the resulting product must finally be multiplied by the average percentage of metal or mineral, as ascertained by estimate or by actual assay. The values in column V. correspond to both the British ton of 2240 lbs., and the American ton (chiefly used in Canada) of 2000 lbs. Where the width of the vein is in feet and inches, the values of the two, as given in the table, must of course be added together.

Example.—A vein averages 3 feet in width, with specific gravity equal to 3·8, and percentage of metal equal to 2·6. Required the weight in British and American tons, and the yield (exclusive of loss in mechanical and furnace treatment) per running fathom.

3 tons (see the Table) × 3·8 = 11½ British tons (nearly).
3·36 tons (see the Table) × 3·8 = 12¾ American tons.
67·30 lbs. (see the Table) × 3·8 × 2·6 = 665 lbs.

Each fathom, therefore, of a vein of this strength will contain 108 cubic feet; will weigh 11½ British, and 12¾ American tons; and will carry 665 lbs. of metal.

I. Width of vein. Feet.	I. Width of vein. Inches.	II. Contents in cubic feet per fathom.	III. Weight in English tons (2240 lbs.), per fathom.	IV. Weight in American tons (2000 lbs.), per fathom.	V. Amount of metal in lbs., average per fathom.
	1	3	0·0833	0·0933	1·87
	2	6	0·1666	0·1866	3·74
	3	9	0·2500	0·2800	5·61
	4	12	0·3333	0·3733	7·48
	5	15	0·4166	0·4666	9·35
	6	18	0·5000	0·5600	11·22
	7	21	0·5833	0·6533	13·09
	8	24	0·6666	0·7466	14·95
	9	27	0·7500	0·8400	16·83
	10	30	0·8333	0·9333	18·70
	11	33	0·9166	1·0266	20·57
1	—	36	1 ton.	1·1200	22·43
2	—	72	2 ,,	2·2400	44·87
3	—	108	3 ,,	3·3600	67·30
4	—	144	4 ,,	4·4800	89·74
5	—	180	5 ,,	5·6000	112·17
6	—	216	6 ,,	6·7300	134·61
7	—	252	7 ,,	7·8400	157·04
8	—	288	8 ,,	8·9600	179·48
9	—	324	9 ,,	10·0800	201·92
10	—	360	10 ,,	11·2000	224·35

ON THE OXIDATION PRODUCTS OF PICOLINE.*

By JAMES DEWAR, F.R.S.E,
Chemical Demonstrator in the University of Edinburgh, and Lecturer on Chemistry at the Edinburgh Veterinary College.

THE combined researches of Anderson and Williams on the basic compounds contained in coal-tar have led to the discovery of two well-defined series of organic bases, called respectively the pyridine and chinoline series, the members of both of which possess the properties of nitrile bases. The isomerism between the pyridine and the aniline series of bases excited considerable interest at the time of its discovery. The subsequent researches of Williams on the products of the distillation of chinchonine led to the discovery of bases having the same composition as the members of the pyridine and chinoline series of coal-tar. When first discovered they were supposed to be identical. Since that time, however, a careful examination and comparison of the tar series of bases with the chinchonine series has led Mr. Williams to the interesting discovery that the two lutidines, as also the two chinolines, are, in reality, not identical, but isomeric. This introduces a greater complexity into the study of the constitution of these compounds.

I began this investigation in the summer of 1867 under the able direction of Professor Aug. Kekulé, in the University of Ghent. At that time the whole of the then known facts regarding the properties of these bases had been accumulated by Anderson and Williams, and by Perkin, who had obtained pyridine from a naphthaline derivative. Save by this latter method the only process of preparation known was destructive distillation. All the attempts that had been made to elucidate the internal constitution and relationship of these bases had failed to yield positive results, their extreme stability in presence of the most powerful reagents presenting a barrier to investigation. In 1869 Professor Adolphe Baeyer made the brilliant synthesis of picoline through the action of tribrom-allyl and of acryl aldehyde, respectively, on ammonia;

* Read before the Royal Society of Edinburgh.

and through the action of higher aldehyde homologues has shown the reaction to be general. Thus, by the synthetical labours of Baeyer, we have acquired for the first time a definite knowledge regarding the mode of formation and constitution of this class of organic compounds.

Having formerly employed permanganate of potassium in the oxidation of phenol (see *Proceedings of the Royal Society of Edinburgh*, Session 1866-67, p. 82), I naturally attempted the oxidation of these bases by the same agent; and I have since found that A. W. Hofmann had successfully employed it to oxidise chinoline into ammonia and oxalic acid. Finding the members of the pyridine series to be easily attacked by this reagent, I commenced a careful examination of the products of the oxidation of picoline, with the object of learning something regarding its internal structure. A preliminary note on the results obtained was communicated to the British Association at its Norwich meeting, 1868 (See Report Brit. Assoc., 1868).

I am indebted to my friend Dr. Ronalds, of Bonnington, for a liberal supply of a quantity of bases that he had carefully prepared, with the object of instituting an investigation into these compounds himself. The crude bases placed in my hands had been repeatedly fractionated on a large scale, and the individual fractions were thus tolerably pure to begin with. Finding they contained traces of pyrrol and hydrocarbons, I re-dissolved in acid the fraction boiling from 130° to 160° C., and subsequently treated it in the way recommended by Anderson and Williams to purify these bodies. The mixture of bases thus obtained was subjected to a series of careful fractional distillations. With the object of effecting the best possible separation, I employed the method recommended by Warren, and found it admirably suited to effect a comparatively easy separation, so far as fractional distillation can be made to yield a pure product. The bases were transferred to a retort connected with an ascending spiral of copper tube enclosed in a paraffine bath of large dimension, the temperature of which was continuously equalised by constant stirring. Five successive fractionations by this method gave a separation as complete as was necessary for the object I had in view. From the laborious researches of Anderson and Williams, we know that these bases for a large range of temperature have the same composition, and that perfectly pure products can be obtained only through the fractional precipitation of the platinum salts. Although I did not make an exhaustive separation by Warren's method, the fractionation was so effective that, by comparing the temperature of the boiling vapour in the retort with the temperature of the paraffine bath throughout the whole course of a distillation, a difference of 10° C. at starting gradually increased to 20°. No fraction that I obtained, separated in this process by a difference of 2° C. in the intermediate condenser, had a perfectly constant boiling-point. On different occasions fractions separated in this way, boiling between 130° and 140° C., have been employed in the following experiments. Analyses of the platinum salts of portions boiling between those temperatures showed the fractions to be substantially picoline, with a possible trace of lutidine.

Picoline, as is well known, resists oxidation by the most powerful agents adapted for this purpose, nitric and chromic acids being without visible action, even at high temperatures. Of all oxidising agents, permanganic acid, or its potassium salt, seems to be the most powerful. Having, on a former occasion, employed this reagent to effect the oxidation of phenol alcohol, I naturally investigated the action effected on these nitrile bases. I found that the whole of the members of this series of compounds could be readily oxidised by the use of this substance. The higher members of the series were oxidised more readily than the lower, but in all cases it was effected with ease and rapidity. The following is a description of the apparatus used in the experiments on the oxidation products of these substances and of the mode of conducting the operation. A flask, about three litres in capacity, was connected by a wide tube with a large reversed Liebig's condenser, so as to effect a rapid condensation of volatil products and their immediate return to the field of chemical action. The flask having been placed on a sand-bath, 150 grms. potassium manganate, 1½ litres water, and 25 grms picoline were introduced, and the whole heated to near the boiling-point. The reaction began suddenly, with great evolution of heat, necessitating the removal of the source of external heat. The reduction of the permanganate was completed in half an hour. After the contents of the flask had cooled, the oxide of manganese was separated by filtration from the strongly alkaline liquid, and washed repeatedly with boilng water. The alkaline liquid was then transferred to a flask, and the basic substances distilled off. The residual alkaline liquid was then concentrated by evaporation to 200 c.c. and 300 c.c. and dilute sulphuric acid (containing 70 per cent H_2SO_4) added to it. After standing for some time, this acid liquid became thick from a deposit of long white crystalline needles of a complex of new acids. In different experiments the relative proportions of the reacting substances were considerably varied, but the yield of the new acids in every case was small, a large portion of the picoline having been completely oxidised, while some of it had remained unacted upon. This must always be the case, as a large quantity of the original base, from the violence of the reaction, was driven away from the flask, and, when condensed, it fell back into a boiling liquid of increasing alkalinity, in which the base was comparatively insoluble. After separating, by filtration, the new crystalline acid referred to, the filtrate was transferred to a retort, and the volatile acids distilled off.

General Results of Oxidation.—When the dilute alkaline fluid was taken immediately after the permanganate was exhausted, it was found to contain carbonate of potassium. When neutralised with hydrochloric acid and chloride of calcium added, a white precipitate of oxalate of calcium was obtained. The oxalate was mixed with a small quantity of some higher acid, probably malonic, as the percentage of lime found was 36·3, oxalate containing 38·3 per cent. The quantity of volatile acid produced by the reaction was small. The presence of nitric and acetic acids, however, was readily proved. The surplus base remaining after the oxidation operation was transformed into the double platinum salt, and a fractional crystallisation made. The platinum was determined in these different salts as follows:—

	grm.		grm.	per cent.
1st Cryst.—	0·1770	pt-salt gave	0·0770	pt = 43·70
2nd ,, —	0·6913	,, ,,	0·2102	,, = 33·95

The first sample agreed in composition with the double chloride of platinum and ammonium; the second, with that of a mixture of the double platinum salts of pyridine and picoline. There was produced by the reaction, therefore, carbonic, nitric, oxalic, acetic, and a complex of new acids, ammonia, and probably a small quantity of pyridine. The relative proportion of the products obtained depended on the quantity of the oxidising agent used, the volume of the solution, rapidity of the action, and the quantity of bases present in the field of action.

Di-carbo-pyridenic Acid, $C_5H_3N\begin{cases}CO_2H\\CO_2H.\end{cases}$

The crystalline acid substance separated by adding excess of sulphuric acid to the alkaline fluid, after standing over night was collected on a filter, and repeatedly crystallised from hot water (in which it was easily soluble) until free from oxalic acid and potassium salts. When first separated fram the acid solution it appeared in long needles; but after several re-crystallisations from water it was obtained in the form of perfectly colourless plates, resembling naphthaline. (The crystallographic constants of this acid have not yet been determined). The crystals did not contain any water of hydration. The following are the results of the analyses of the acid and its silver salt:—

Acid.

	Grm.
Weight of acid taken	0·2195
Carbonic anhydride produced	0·0685
Water produced	0·4040

Nitrogen found by Gottlieb's method to bear to the CO_2 produced, the proportionate vol. of, 1 to 14·2

Calculated centesimally these figures give—

	Samples.	$C_7H_5NO_4$.
Carbon	50·19	50·29
Hydrogen	3·47	2·99
Nitrogen	—	—

*Silver Salt.**

As with the acid, the salt was dried at 100° C.

	I.	II.
Weight of salt taken	0·8766	0·5456
Carbonic anhydride produced	0·6985	0·4518
Water produced	0·0554	0·0602
Weight of salt taken	0·6980	0·3951
Silver obtained	1·5111	0·6525

Calculated centesimally these results give—

	I.	II.	$C_7H_3NAg_2O_4$.
Carbon	21·73	22·58	22·04
Hydrogen	0·70	1·22	0·78
Silver	56.60	56·78	56·69

In order to determine the equivalent of the acid, I took 0·5392 grm. of acid dried at 100° C. and titrated with pure caustic soda solution, every 1·813 c.c. containing 23 mgrm. of sodium; 11·7 c.c. of soda neutralised the acid taken. The point of saturation was well marked. The equivalent of the acid, from this determination was, therefore, 83·55; as determined by analysis of the silver salt it was 83·5. The atomic weight of the acid taken as $C_7H_5NO_4$ was exactly double the equivalent found, which, if true, would necessarily involve the acid being bibasic. In order to determine the basicity of the acid, the ammonium salts were the only combinations that I specially examined. 0·4739grm. of the acid carefully treated with excess of ammonia, and dried at 100° C., increased in weight by 0·0481 grm., gain = 10·13 per cent; gain on the acid ammonium salt of foregoing formula = 10·17 per cent. The neutral ammonium salt was extremely soluble in water, whereas the acid salt was much less soluble, and could readily be obtained in the form of fine silky needles when the solution was evaporated. From the above data there can be little doubt that the acid was bibasic, bearing the same relation to pyridine that phthalic acid does to benzol. The acid melted at a temperature of about 210° C., frothed, evolved a small quantity of carbonic anhydride, and emitted the readily recognisable smell of these bases. It was easily decomposed when heated with soda-lime, evolving a basic substance, no doubt pyridine. The mercury, copper, cadmium, and zinc salts were all readily soluble in water. The barium and calcium salts were also soluble, and were obtained by adding the respective chlorides to the neutral sodium or ammonium salt; they crystallised in minute prismatic needles. The silver salt of this acid was specially characteristic. On the addition of nitrate of silver to a solution of the acid or its neutral ammonium salt, a white gelatinous precipitate immediately separated out—it was insoluble in boiling water, and was not visibly affected by exposure to light. The insolubility of this salt would enable us more readily to separate the acid from the other products of the oxidation reaction than the process first quoted in this paper.

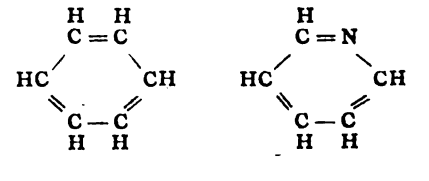
Along with the acid just described, as separated by the process detailed, there was found associated with it another acid substance having a very much higher atomic weight. The crystalline mass, obtained by the addition of sulphuric acid to the alkaline liquid from the oxidation operation, purified by solution in and re-crystallisation from alcohol, and dried over sulphuric acid by means of an air-pump, had an equivalent weight of 121. The crystals were hydrated, and lost 4·9 per cent of their weight when dried at 100° C. The sodium salt of this mixture gave, on the addition of nitrate of silver, a gelatinous precipitate agreeing in appearance and composition with that got from dicarbopyridenic acid; it contained 56·6 per cent of silver. The equivalent of this mixture, as determined by the composition of the ammonium salt dried at 100° C., was 336; 0·8335 grm. of acid mixture dried at 100° C., and treated with ammonia, increased in weight by 0·0422 grm. This acid substance, therefore, was clearly a mixture of dicarbopyridenic acid with some acid of a very much higher atomic weight. It remained solid when heated to 220° C., at which temperature dicarbopyridenic acid readily melted, and was much less soluble in water than the latter.

The difficulty and expense of obtaining these oxidation products in any quantity, prevented me from making the exhaustive investigation I would have liked.

The formation of dicarbopyridenic acid by the oxidation of a mixture of picoline and lutidine, whether obtained from lutidine alone or by the complete destruction of picoline, is quite analogous to the formation of phthalic or teraphthalic acid, by the oxidation of the homologues of benzol, or by the complete destruction of benzol itself, as shown by Carius; the only difference being that Carius employed the lowest member of the benzol series, whereas picoline is the second known member of the basic series. The production of the same acid from pyridine itself would in no wise influence speculation regarding the constitution of the high members of the series. For the present, we may consider pyridine as the nucleus from which all the other members of the series are derived. Athough such a supposition must be considered purely hypothetical, in reality it is a great advantage to classify by analogy, relatively to other series, disjointed groups of organic compounds. The two series of bases, viz., the coal-tar and the chinchonine, bear the same empirical relation to pyridine that benzol does to its homologues and to naphthaline.

Benzol.	Toluol.	Naphthaline.
C_6H_6	C_6H_6	C_6H_6
	CH_2	C_4H_2
Pyridine.	**Picoline.**	**Chinoline.**
C_5H_5N	C_5H_5N	C_5H_5N
	CH_2	C_4H_2

Now, although it has not yet been proven that lutidine and chinoline have a similar formative relation to pyridine that toluol and naphthaline have to benzol, still it is by no means an improbable analogy. The isomerism in the pyridine series, so far as is known, commences with the third member, lutidine, as found by Williams on comparing the chinchonine lutidine with the coal-tar lutidine; whereas the chinoline obtained from either source differs essentially in chemical characters. If we consider picoline as in all likelihood methyl-pyridine, then the α and β lutidines may, in all probability, be represented as dimethyl and ethyl-pyridine respectively, and we would expect the dimethyl-pyridine to give directly dicarbopyridenic acid, or an isomer, on oxidation. Pyridine may be written graphically as benzol in which nitrogen functions in place of the triatomic residue CH‴, and thus may be represented as a closed chain:—



* I. and II. were samples of silver salts obtained from different experiments. I. was by double decomposition of the sodium salt; II. from the ammonium salt.

And, considering the stability and mode of formation of these bases it is not at all improbable that they may not be produced by the simultaneous action of acetylene and its derivatives on hydrocyanic acid; thus as three molecules of acetylene condense and form benzol, so may two molecules of acetylene, and one of hydrocyanic acid, condense and produce pyridine.

There is a large class of substances that bear the same relation to the monamines that dicarbopyridenic acid does to pyridine, with this difference, that the best known are all monobasic instead of being bibasic acids. Thus glycocol, alamine, leucine, and their homologues, may be looked upon as the monocarbo-acids of the ethylamines, in which the carboxyl radicle is united directly to the carbon, the isomeric carbamic acids (or urethanes, as they are called) being the derivatives in which the carboxyl is united directly to the nitrogen :—

Ammonia.	Methylamine.	Glycocol.	Methyl-carbamic Acid.
H	CH_3	CH_2CO_2H	CH_3
N H	N H	N H	N H
H	H	H	CO_2H

Analogous derivatives are obtained from the aromatic ammonias. A class of derivatives similar to the above, must necessarily be derivable from the diamines. In the case of the nitrile bases or triamines, only derivatives could be obtained analogous to glycocol and its homologues. Bodies of a like constitution to glycocol readily break up into carbonic anhydride, and the corresponding ammonia; the reverse transformation has not yet been effected. The amido-bibasic acids bear the same relation to the monamines that dicarbopyridenic acid does to pyridine, with the exception of the difference in the constitution of the closed nitrile nucleus. No bibasic acid, other than pyridenic, has been discovered. A strictly analogous compound, in the monobasic series, is the acid carbo-pyrrolic, $C_5H_5NO_2$, which bears a similar relation to pyrrol that the amido-mono-carbon acids do to the ammonias, only that the pyrrol, although a nitrogenous body, is not, strictly speaking, a nitrile base. But the close analogy between pyrrol and true nitrile bases, they being simultaneously produced in the majority of reactions, would lead us to expect a like class of derivatives being obtainable from pyridine.

Hübner (*Ann. Chem. u. Pharm.*, vol. 141) has described the oxidation products of nicotine, got by the action of sulphuric acid and bichromate of potassium. In that memoir he describes an acid so obtained, having the formula $C_5H_5NO_2$. This acid is identical in composition with mono-carbopyridenic acid. The base nicotine

Nicotine.	Dipyridine.
C_5H_7N	C_5H_5N
C_5H_7N	C_5H_5N

itself differs from dipyridine by only four hydrogens; and as the nucleus of nicotine is a nitrile nucleus, it is not at all improbable that this acid may be a member of the series to which dicarbopyridenic belongs, so that nicotine may be similarly constituted to Anderson's polymerised bases.

The stability of these bases to the majority of reagents (especially the primary member of the group, pyridine) would predispose us to look upon it as analogous to benzol, and to suppose that the atoms are symmetrically grouped. The syntheses of Baeyer support this view, and there is not any reason why we may not have as many stable derivatives from this nucleus as from benzol. I have already pointed out the analogy between the chinoline series and the pyridine series, and in a short time I hope to be able to publish details supporting the theoretical relations above given.

In the meantime, the following analogies may be pointed out between benzol and nitrile derivatives; thus :—

Benzol.	Naphthaline.	Anthracene.	Pyridine.	Chinoline.
C_2H_2	C_6H_4	C_6H_4	C_2H_2	C_5H_3N
C_2H_2	C_2H_2	C_2H_2	NCH	C_2H_2
C_2H_2	C_2H_2	C_6H_4	C_2H_2	C_2H_2

Indol, from its general characteristics, evidently belongs to the pyrrol series, the following showing, in all probability, the relative structure of indol and pyrrol :—

Indol.	Pyrrol.
C_6H_4	C_2H_2.
NH	NH
C_2H_2	C_2H_2

According to this hypothesis indol is simply benzol-pyrrol.

CHEMICAL TABLES ACCORDING TO THE THEORIES OF MODERN CHEMISTRY.*

By Professor ALBERT R. LEEDS.

(Continued from page 30.)

TABLE IV.

Atomic Weights according to the Modern Chemistry.

Element.	Quantivalence.	Atomic symbol	Atomic weight.	Logarithm.	Ar. Co.
Aluminum	II. or IV.	Al.	27·48	1·43902	8·56098
Antimony	III. or V.	Sb.	122·34	2·08757	7·91243
Arsenic	III. or V.	As.	75·00	1·87506	8·12494
Barium	II.	Ba.	137·02	2·13678	7·86322
Bismuth	III. or V.	Bi.	210·34	2·32292	7·67708
Boron	III.	B.	11·00	1·04139	8·95861
Bromine	I.	Br.	79·97	1·90293	8·09707
Cadmium	II.	Cd.	112·00	2·04922	7·95078
Cæsium	I.	Cs.	133·00	2·12385	7·87615
Calcium	II.	Ca.	40·02	1·60228	8·39772
Carbon	IV.	C.	12·00	1·07918	8·92082
Cerium	II.	Ce.	91·33	1·96061	8·03939
Chlorine	I.	Cl.	35·50	1·55023	8·44977
Chromium	II. or IV.	Cr.	52·54	1·72049	8·27961
Cobalt	II.	Co.	59·08	1·77144	8·22856
Columbium	V.	Cb.	98·45	199·322	8·00678
Copper	II.	Cu.	63·44	1·80236	8·19764
Didymium	II.	D.	95·84	1·98155	8·01845
Erbium	II.	E.	112·60	2·05154	7·94846
Fluorine	I.	F.	19·00	1·27875	8·72125
Glucinum	II.	G.	9·29	0·96802	9·03198
Gold	III.	Au.	196·73	2·29387	7·70613
Hydrogen	I.	H.	1·00	—	10·00000
Indium	II.	In.	75·63	1·87869	8·12131
Iodine	I.	I.	127·00	2·10380	7·89620
Iridium	II. or IV.	Ir.	197·13	2·29476	7·70524
Iron	II. or IV.	Fe.	56·00	1·74819	8·25181
Lanthanum	II.	Ln.	92·80	1·96755	8·03245
Lead	II.	Pb.	207·00	2·31597	7·68403
Lithium	I.	L.	7·00	0·84510	9·15490
Magnesium	II.	Mg.	24·60	1·39094	8·60906
Manganese	II. or IV.	Mn.	54·96	1·74005	8·25995
Mercury	II.	Hg.	200·20	2·30146	7·69854
Molybdenum	VI.	Mo.	96·00	1·98227	8·01773
Nickel	II.	Ni.	59·02	1·77100	8·22900
Nitrogen	III. or V.	N.	14·00	1·14613	8·85387
Osmium	II. or IV.	Os.	198·80	2·29842	7·70158
Oxygen	II.	O.	16·00	1·20412	8·79588
Palladium	II. or IV.	Pd.	106·56	2·02760	7·97240
Phosphorus	III. or V.	P.	31·00	1·49136	8·50864
Platinum	II. or IV.	Pt.	197·88	2·29641	7·70359
Potassium	I.	K.	39·13	1·59251	8·40749
Rhodium	II. or IV.	R.	104·32	2·01836	7·98164
Rubidium	I.	Rb.	85·4	1·93146	8·06854
Ruthenium	II. or IV.	Ru.	104·20	2·01787	7·98213
Selenium	II. or VI.	Se.	79·24	1·89894	8·10106
Silicon	IV.	Si.	28·02	1·44747	8·55253
Silver	I.	Ag.	107·95	2·03322	7·96678
Sodium	I.	Na.	23·05	1·36267	8·63733
Strontium	II.	Sr.	87·48	1·94191	8·05809
Sulphur	II. or VI.	S.	32·00	1·50515	8·49485
Tantalum	V.	Ta.	182·00	2·26007	7·73993
Tellurium	II. or VI.	Te.	129·00	2·11059	7·88941
Terbium	—	Tb.	75·36	1·87714	8·12286
Thallium	I. or III.	Tl.	204·00	2·30963	7·69037
Thorium	IV.	Th.	238·00	2·37658	7·62342
Tin	II. or IV.	Sn.	118·06	2·07210	7·92790
Titanium	II. or IV.	Ti.	50·34	1·70191	8·29809
Tungsten	VI.	W.	184·00	2·26482	7·73518
Uranium	III. or V.	U.	118·86	2·07510	7·92490
Vanadium	III. or V.	V.	51·33	1·71037	8·28963
Yttrium	II.	Y.	61·70	1·79029	8·20971
Zinc	II.	Zn.	65·06	1·81331	8·18669
Zirconium	IV.	Zr.	89·60	1·95231	8·04769

(To be continued).

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JOULE AND SCORESBY'S EXPERIMENTS ON THE MECHANICAL POWERS OF ELECTRO-MAGNETISM, STEAM, AND HORSES.

By the Rev. H. HIGHTON, M.A.

SOME weeks ago I promised an examination of Jacobi's paper on "Electro-Dynamic Engines," in *Ann. de Chim. et de Phys.*, vol. xxxviii.; I have not lost sight of the matter, but think it as well to examine first Joule and Scoresby's experiments as given in the *Philosophical Journal* [3], xxviii.

Let me say how exceedingly valuable I consider Joule's experiments generally, and how fully I appreciate his title to the honours that have been bestowed on him; but, at the same time, though his experiments are exceedingly valuable for the legitimate conclusions which may be drawn from them, yet I consider that the deduction, that heat has a definite mechanical equivalent, and that the admission of the supposed axiom of conservation of energy as applied to electricity and heat as well as mechanics, or rather to electricity and heat as connected with mechanics, has done great mischief in a scientific point of view, and thrown back the progress of the science of electro-dynamics for many years.

The paper I now propose to examine contains in itself a sufficient refutation of these views; and it appears astonishing that it should have been allowed for so long to be quoted as a reliable authority in support of them..

Let me first give a brief description of their experiments. They first fixed strong permanent magnets; they next formed electro-magnets which, by means of commutators and the aid of a galvanic battery, rotated in front of the permanent magnets; by this rotation, through the medium of proper machinery, they raised weights. They measured and compared the intensities of the current and the consumption of zinc, when the engine was at rest and when it was at work, and compared the work done with the zinc consumed. So far, there is nothing to object to; it is their reasonings on the facts, and the mathematical formulæ which they introduce, which, to my mind, require nothing but an examination to show how hopelessly wrong is the theory of a definite mechanical equivalent of heat. They begin by asserting that as the heat evolved in a circuit is (*cæteris paribus*) as the square of the intensities; therefore, if a and b represent respectively the intensity (and, consequently, the consumption of zinc) when the engine is at rest and when it does work, the heat evolved in the two cases will be as a^2 to b^2; but, as this is not a case of *cæteris paribus*, there seems no reason why this statement is introduced, or what bearing it has on their experiments; and no use is made afterwards of this assumption, but they estimate in the sequel the heat produced by the quantity of zinc consumed. But Messrs. Joule and Scoresby's next computation is the one I wish particularly to draw attention to, as nothing can better show how utterly untenable are their views of the subject. They say that "the quantities of zinc consumed" (that is, respectively, when the engine is at rest and doing work) "being as a to b, $(a-b)$ represents the quantity of heat converted by the engine into useful mechanical effect." Therefore, since on the supposition of a mechanical equivalent of heat a grain of zinc consumed equals 158 foot-pounds, if x = pounds raised a foot high per consumption of a grain of zinc in the battery,—

$$x = \frac{(a-b)158}{a}$$

Hence the authors draw the conclusion:—"Therefore, when b vanishes, or becomes infinitesimally small, the economical duty is a maximum."

Certainly this is a most startling result; that the maximum of work should be done when no zinc at all is consumed! But it is quite evident that the authors assumed, and framed their equation on the assumption, that the battery produced the same amount of heat, whatever quantity of zinc was consumed; but that part of the heat was absorbed and disappeared in doing work. But I need hardly say that this assumption is entirely erroneous, that the only possible source of heat could be the consumption of zinc, and that when the zinc consumed fell from 500 to 200 grains per hour, the difference of heat corresponding to the two quantities could not be absorbed or disappear because it never was produced at all. It is really difficult to imagine how conclusions based on such a formula and on such a theory, would ever have been accepted. I am sure it is only necessary to call attention to it in order that the error should be recognised. I can scarcely help imagining that I must have misunderstood the authors' meaning; but I really cannot see how the equation or their statements will bear any other interpretation. Seeing, then, that this was the formula on which their calculations were based, no wonder if the results were not according to their calculations. In their first experiment they calculated that 92·9 pounds should be raised a foot per grain of zinc consumed; 102·9 were actually raised. In their second they calculated 97·8; the result was 93·8. When, according to the theory, the duty should have been less, it was actually more. The only wonder is (and it can have been due to little more than accident) that the agreement was anything nearly as great as what it is. They attributed the excess of performance over calculation to the fact that the acid of the battery was rather warm, and that, therefore, the battery produced greater intensity of current. But they forgot that if it produced greater intensity of current more zinc would be consumed, so that this would make so difference to the duty of a grain of zinc. I pass over their other experiments; for, inasmuch as in these they substituted for the electro-magnets used in the first experiments less powerful and less skilfully constructed ones, no wonder if they reduced the results to 34 foot-pounds per grain of zinc. They might in the same way have reduced the economical effect to any extent. But after having thus reduced the economical duty of a grain of zinc by badly constructed electro-magnets, it is very unfair to strike a kind of average, and to say that the *maximum* practical power of a grain of zinc is 80 foot-pounds, whereas they had themselves got 102·9 foot-pounds.

Well, now let us look at the general result of the real facts. They calculate the maximum theoretical power of a grain of zinc to be 158 foot-pounds, and yet, using permanent magnets, which, by their own statement, were so badly constructed as to have only a quarter the power they ought to have had, with the poles of the electro-magnets never approaching the permanent magnets nearer than ¼ of an inch (and what an enormous loss is incurred here!); with an engine constructed almost at hap-hazard, and with scarcely a consideration of the best principles or of the most advantageous construction of such engines, they actually obtained a result of 102·9 foot-pounds out of a calculated theoretical maximum of 158. With a little care and consideration, I do not hesitate to say the duty per grain of zinc might easily have been increased ten-fold.

Now contrast this with what they tell us of the performance of a steam-engine. The best steam-engine, according to their account, produces only about one-tenth of the theoretical duty of the mechanical equivalent of the coal consumed; and a horse only about a quarter of the theoretical duty of the hay and oats which he consumes, and yet in an electro-dynamic engine constructed at hap-hazard, without any definite principles or calculation of economy, about two-thirds of the maximum theoretical duty is at once secured.

I conclude, then, that these experiments, instead of being supposed to have confirmed, should at once have shown the falsity of the theorem of a definite mechanical equivalent of heat or chemical change.

Putney, January 7, 1871.

PS. I find that in a letter, a few weeks ago, on the question of whether a magnet, in contact with a piece of

soft iron, produces a pole of an opposite name or of the same name only, I did an injustice to Professor Tyndall in assigning the first correction of the mistake to Du Moncel, in 1858. Tyndall pointed out the error in 1851, and says he finds that Poggendorff and Van Rees had both also made the same observation. Is it not strange that now for twenty years all our text-books (as far as I know) go on repeating the error?—H. H.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 19th, 1871.

Professor ODLING, F.R.S., Vice-President, in the Chair.

THE following gentlemen were elected Fellows:—R. Bannister, H. T. Brown, J. Moss, R. J. Moss, E. Potts. The following papers were read:—

"*On the Action of Sulphuric Acid on the Natural Alkaloids*," by HENRY E. ARMSTRONG.

The action of sulphuric acid on the natural alkaloids was first made the subject of investigation by Arppe, who, in 1845, shortly described a body obtained from morphine, to which he gave the formula $4(C_{35}H_{40}N_2O_6)+5SO_3$. Laurent and Gerhardt, led by their researches on the amides and anilides to doubt the correctness of this formula, as, if true, a reaction had taken place entirely without analogy, re-investigated the matter, including both morphine and narcotine in their experiments. From the results obtained they considered the composition of the bodies which they succeeded in preparing, to be represented by the formulæ $C_{54}H_{36}N_2O_8S$ and $C_{46}H_{52}N_2O_{18}S$, and termed them respectively, sulphomorphide and sulphonarcotide, looking upon them as derived from the neutral sulphates of the bases by the abstraction of the elements of two molecules OH_2.

$$2C_{17}H_{19}NO_3.H_2SO_4-2OH_2=2C_{17}H_{18}NO_3.SO_2,$$
$$2C_{23}H_{25}NO_7.H_2SO_4-2OH_2=2C_{23}H_{24}NO_7.SO_2.$$

They considered them, in fact, to be true amides, and as bearing the same relation to the neutral sulphates of the respective bases as do sulphamide and sulphanilide to the neutral sulphates of ammonia and aniline.

By the action of SO_4H_2 on codeine, they obtained a body identical with it in composition, and to which they gave the name of modified or amorphous codeine.

The light thrown on the constitution of the organic bases by the researches of Dr. Matthiessen and others rendered it highly improbable that the above-mentioned bodies were constituted as Laurent and Gerhardt believed, for the discovery of apomorphine at once seemed to point to the possibility of the morphine product being none other than the sulphate of that base. Their identity was proved by Drs. Matthiessen and Wright, who succeeded in isolating apomorphine from the product of the reaction of sulphuric acid on morphine in sealed tubes at 100°. This rendered an analogous constitution of the narcotine and codeine products probable, a surmise which has, however, not been confirmed by experiment.

On heating narcotine with an excess of acid, of the strength of equal volumes of ordinary concentrated sulphuric acid and water in an open porcelain dish on a water-bath, it is observed that the colour of the mass gradually darkens, and that, after a time, and almost suddenly, the whole becomes of a dark pink colour. It is then thrown into a considerable quantity of warm water, in which it entirely dissolves, and a slight excess of NH_4OH added, which throws down the base as an amorphous, almost white precipitate. This was brought on a filter and washed with warm water. It was found to be very easily soluble in alcohol, insoluble in Na_2CO_3, readily soluble in KOH, and when heated under water to cake together in the form of a sticky semi-fluid mass. This behaviour at once suggested the probable nature of the base, for all the above properties agree with those exhibited by the first product of the action of HCl narcotine, viz., dimethylnarcotine, and a further examination proved this to be the case. It was purified, dried at 100°, and analysed. The figures obtained lead to the formula $C_{21}H_{21}NO_7$. The reaction has, therefore, taken place according to the equation—$C_{22}H_{23}NO_7+H_2SO_4=C_{21}H_{21}NO_7+CH_3HSO_4$. The methylsulphorinic acid is then further decomposed.

On treating codeine in a similar manner, and heating until the precipitate produced by Na_2CO_3, did not visibly increase, dissolving the product in water, precipitating with Na_2CO_3, re-dissolving in HCl, re-precipitating with Na_2CO_3, which operation was twice repeated in order to remove any codeine, then, extracting with ether, and shaking up the ether with HCl, a crystalline hydrochlorate was obtained which, on analysis, gave numbers agreeing with those calculated for codeine hydrochlorate. The first product of the action of H_2SO_4, on codeine, is, therefore, a body isomeric with it. The hydrochlorate crystallises in hexagonal pyramids, radiating from a common centre, and differs from the corresponding codeine hydrochlorate by losing both its atoms of water of crystallisation at 100°. The platinum salt is amorphous, and may be obtained anhydrous by drying at 100°, whereas the platinum salt of codeine is crystalline, and does not lose the whole of its water of crystallisation below 120°.

By the further action of sulphuric acid one molecule of H_2O is taken out from two molecules of codeine, then one of H_2O from one of codeine, and by still advancing action CH_3 is removed, and thus apomorphine formed. On this point, however, some more evidence is required.

Other bases, like strychnine and papaverine, are not in the least affected by H_2SO_4.

"*On the Origin of Nitrates in Potable Waters*," by CH. EKIN.

The author found considerable quantities of nitric acid in spring water, for which he could not account by supposing it to come from some sewage contamination. Closer examination showed that the water in question had passed through a fossiliferous stratum. This observation necessitates a modification of the "previous sewage contamination theory."

"*On an Alkaloid from Cinchona Bark hitherto undescribed*," by D. HOWARD.

In experimenting upon impure crystallisations of salts of quinine obtained from the mother liquors of the manufacture of sulphate of quinine, I have occasionally been perplexed by an unusual loss in re-crystallising, which the mechanically adhering mother-liquor did not seem to account for.

A more careful examination of some of these substances shows that the cause, in some cases at least, is the presence of an alkaloid hitherto undescribed, the extreme solubility of the salts of which both distinguishes it at once from the cinchona alkaloids already known, and renders it very difficult to separate from the uncrystallisable quinoidin.

The most convenient method of obtaining it is to purify the alkaloids contained in the mother-liquor from the re-crystallisation of such impure products as I have mentioned by solution in ether, and, after evaporation of the ether, to dissolve with oxalic acid in as small a quantity of water as possible, and to allow it to crystallise. The oxalate thus obtained may be purified by re-crystallisation from water with the addition of animal charcoal, but I have never been able to free it entirely from a yellow colour.

The most satisfactory salt for analysis is the platinochloride, which is prepared in the usual manner. It is almost insoluble in water or in cold hydrochloric acid; it

forms a crystalline powder by precipitation, and well-defined crystals by solution in acid.

The analysis shows that it is isomeric with the platino-chloride of quinine, but anhydrous, instead of containing one atom of water of crystallisation given off at 120°, as does the salt of quinine.

The author has investigated the sulphate, tartrate, citrate, hydrochlorate, phosphate, and sulphocyanide of the new base. He has, however, not yet found out whether this alkaloid is contained in all the species of cinchona, or, if not, in which of them. He hopes to settle this question at some future time.

At the conclusion of the meeting Mr. Macleod exhibited an ingenious little contrivance by means of which eudiometer tubes which have lost the outer portion of their discharging wires may yet be made use of.

NOTICES OF BOOKS.

Beet-Root Distillation; Containing a Report on the subject by Dr. A. Voelcker. F.R.S., &c., and Particulars and Prices of Beet-Root Distilleries. D. Savalle, and Co., Paris, and 10, Basinghall Street, London.

THIS pamphlet, copiously illustrated with woodcuts, representing the stills and some of the accessory apparatus, is divided into the following sections:—Introduction; Extracts from Reports; List of Some of the Most Important Distilleries; Dr. Voelcker's Report; Opinion of the Right Hon. J. Howard, M.P., and W. Crookes, F.R.S., on the Savalle Stills; a short paper taken from the *Food Journal*; Is Beet-Root Distillation Profitable? Beet-Root Distillation and Sugar Making; Value of Beet-Root Grown in Great Britain; Value of the Pulp as Food for Cattle; What is Beet-Root Spirit good for? Usefu! Information; Erection of Distilleries; Alphabetical Index. The work, the contents of which we have just quoted, contains a very large amount of useful knowledge for landowners aud farmers who can lay out a portion of their capital so as to convert part of their estate to what may be termed agricultural industry. It appears, from Dr. Voelcker's report, by far the most interesting and valuable portion of the book, that the distilling and rectifying Savalle stills, which the Doctor saw in operation on Mr. R. Campbell's estate, Buscot, Berkshire, produce an extremely pure alcohol of very high strength, and not distinguished in any way from pure spirit of wine. We are, moreover, informed by the same author that distilling and refining the crude beet-root by these stills may be carried out by any man of moderate means and ordinary intelligence, for in great measure they may be said to be self-regulating, while, in point of economy and superiority of the products of distillation, the apparatus alluded to leaves little to be desired. We can recommend this little book, in the first place, to all agriculturists who desires to gain information on an important subject, and, secondly, to all who take an interest in the progress and improvements of technology and industrial art.

Victoria.—Patents and Patentees from 1854 *to* 1866 (both inclusive). Vol. ii., Indices for the year 1867. Vol. iii., Indices for the year 1868. Compiled from Specifications lodged in the Patent Office attached to the Registrar General's Department, Melbourne. By WILLIAM HENRY ARCHER, Registrar General of Victoria. Melbourne: by authority, John Ferres, Government Printer.

FROM the works, of which we have just quoted the titles, some idea may be obtained of the high state of industrial importance already prevailing in the comparatively young colony of Victoria. The arrangement of these official publications is very similar to that adopted for this subject at the Patent Office of the United Kingdom, where the above-named books can be inspected.

CORRESPONDENCE.

THE SEWAGE QUESTION.

To the Editor of the Chemical News.

SIR,—I have only to day been able to read Mr. Stanford's paper on this subject which appeared recently in the CHEMICAL NEWS (vol. xxii., pp. 289, 301), but perhaps in view of the extreme importance of the subject you will still allow me to say a few words in reply, especially as my friend Mr. Stanford evidently intended to "draw" me.

I desire first to point out that in quoting from a paper I read last year at the Society of Arts, Mr. Stanford has made it appear that I was seriously contemplating "a convalescent hospital for diseases of the chest in the middle of my sewaged fields," whereas I was laughing at some theories of my friend Dr. Carpenter (of Croydon), and reducing them to a *reductio ad absurdum* by suggesting, as their logical sequence, a "copropathic establishment" on my farm at Romford.

In another place Mr. Stanford triumphantly exclaims that I have never disproved some "assertions" which he had made in a previous paper which appeared in the CHEMICAL NEWS (vol. xix., p. 255), but the simple truth is that as reading the CHEMICAL NEWS is, with me, a matter of relaxation and not a matter of business, I am not always able to read it, and I never *saw* his other paper, but as he now repeats his "assertions," and I thus have cognisance of them for the first time, I have much pleasure in contradicting them, and beg to apologise to him for not having done so before. He "asserts"—and I am glad he admits it is only an assertion—that "irrigation puts an amount of money value on the ground out of all proportion to the return obtained by the ratepayers." I admit that this statement is perfectly true of the great majority of sewage farms at this moment, but this is not because of any fault in the principle of sewage irrigation, but owing to the ignorance of those who have laid out the farms. As a rule, the area of the land is quite insufficient for the population, and the method of distribution is also wasteful. For the sewage of the town of Romford, I already pay not far from 2s. per head of the population, and, I believe, the full value of the manurial constituents of sewage will be given by farmers at no distant day, as soon as they understand how to use it, which I am teaching them as fast as possible.

With regard to Mr. Stanford's allusion to Dr. Spencer Cobbold's views as to irrigation, I would only say that, although I have the greatest admiration for Dr. Cobbold's talent and indefatigable researches, and consider that as a helminthologist his authority is second to none, yet I do not feel in any way compelled to agree with him in these particular views, because he has not a single *fact* to adduce in support of them.—I am, &c.,

W. HOPE.

Parsloes, January 22, 1871.

CHLORALUM AS A DISINFECTANT.

To the Editor of the Chemical News.

SIR,—My friend Dr. Ballard has done good service by stimulating discussion and investigation as to the nature of a disinfectant. He asks accomplished microscopists such as Dr. Beale and Dr. Sanderson to determine the destructive powers of reputed disinfectants on "those minute amoebiform particles of matter which constitute the simplest form of living things," and he calls for repeated and prolonged observation, of the use of any reputed disinfectant, in the arrest of the spread of contagious disease. No one can doubt the wisdom of these suggestions. Regarding, however, chloralum, permit me to

inform Dr. Ballard that it shrivels, arrests the movements, and kills the amœbiform particles above referred to, and it does more—it destroys many of the lower forms of parasitic life, whether animal or vegetable.

Dr. Ballard well knows how impossible it is to anticipate time and secure such co-operation as is required for "repeated and *prolonged* observations" relating to contagious diseases prevention.

Since I first thought of the chloride as an antiseptic, just a year ago, much work has been done in regard to the process of its manufacture and determining its chemical properties and physiological action.

In writing to the *Lancet*, last autumn, I published a number of general results based on careful observations, and asked for co-operation on the part of medical men to determine, as promptly as possible, how far the chloride of aluminium was available in medicine. I should have asked in vain if all had acted as Dr. Ballard has done, and not tried chloralum, notwithstanding "abundant opportunities of doing so." Fortunately it has been tried; several important facts have come to light and some have been published.

It was full six months after my first experiments with chloralum that I wrote a line about it, and then to the medical papers asking others to investigate and report. I cannot conceive a more desirable course to be adopted, when an agent, calculated to be universally available for sanitary purposes, presents itself to one who has for many years laboured at the subject of contagious disease prevention.

That carbolic acid is not universally available, I believe is so widely admitted, that I can leave it to be settled by medical opinion whether or not I am in error when I state that the odour has affected to a large extent the use of the agent, notwithstanding that it is, as I have frequently stated, "a most efficient agent for destroying contagia."

Very recently, the vague distinctions between antiseptics and disinfectants have struck me as quite unwarranted. I am now convinced that every good antiseptic is really a destroyer of disease germs. Tar and its compounds, arsenious acid, sulphuric acid, sulphates of iron and copper, sulphurous acid and sulphites, hydrochloric acid and certain chlorides, are all disinfectants if used in such a way that an antiseptic action, or, in other words, *an arrest of development*, is ensured. I consider this an important generalisation tending to "a grand clearance of our foggy notions about disinfectants."

Dr. Ballard is well aware that I do not rest in my work, and I trust he may, in future, honour me by deeming my suggestions—never made without thought and some research—of sufficient importance to merit being tested by experiment. Chloralum is harmless, and in virtue of its harmlessness can be used more freely than any other disinfectant in the sick room. For those who have not read what I have previously written on this subject it may be as well to add that the properties of chloralum are almost identical with the active *antiseptic and disinfectant* properties of hydrochloric acid. The aluminium base gives an available and innocent compound of this undoubted antidote to contagion.—I am, &c.,

JOHN GAMGEE.

January 23rd, 1871.

ANTISEPTICS AND DISINFECTANTS.

To the Editor of the Chemical News.

SIR,—Mr. Gamgee has been allowed to protest in your columns against Dr. Calvert's recently published experiments with antiseptics. You will no doubt permit me also to enter my protest, not only against those experiments, but likewise against Mr. Gamgee's assertions, wherein my name has been somewhat gratuitously introduced.

My main objection to Dr. Calvert's experiments is that he has classed permanganate of potash (Condy's fluid) among antiseptic agents, whereas that substance has in reality nothing in common with those bodies. There is no scientific warrant whatever for considering permanganate of potash to be possessed of "colytic" or preserving properties, except very indirectly. The disinfecting effects produced by the alkaline permanganates are due, not to antiseptic virtues, but to their oxidating powers. In this respect they resemble free air. You will, I think, agree with me that the latter agent, which is the one whereby ventilation operates as a disinfectant, is no antiseptic. One of the great aims in the preservation of food, for instance, is the exclusion of air. It would therefore seem to me that to class the permanganates with antiseptics, and to experiment with them as such, is much the same thing as to class in that category pure air and experiment with it in the apparent expectation that it might prove capable of preserving from decomposition organic bodies. I cannot see that any good would arise from proving that free air has no antiseptic value; but, on the contrary, believe that only misapprehension as to the value of that essential to health would thereby be engendered in the public mind. which is not yet sufficiently instructed to distinguish between antiseptics and disinfectants. In the same way, experiments undertaken to prove that permanganates are destitute of antiseptic properties, which everyone qualified to experiment already knows, instead of being of any service to sanitary science, must, on the contrary, when published, be detrimental thereto, by erroneously leading popular opinion to conclude that they are therefore inefficient disinfectants, which is exactly the contrary to the truth.

What I chiefly object to in Mr. Gamgee's protest are the following words:—"Condy's fluid, valuable in its way, has been supposed to act like carbolic acid, physicians prescribing it gladly in the erroneous belief that it added to its deodorising properties that of destroying disease germs. Its success has been due to its freedom from odour." In saying that Condy's fluid has been supposed to act like carbolic acid, Mr. Gamgee, I presume, knew by whom such a supposition has been entertained. Whoever he may have been, he was no great chemist, for hardly any two bodies could be more opposed in their nature and mode of action than Condy's fluid and carbolic acid. The former is an oxidating agent, whose effects are similar to those of ventilation by pure air; the latter is a deoxidating agent which, when added to pure air, vitiates it, inasmuch as it behaves exactly like animal respiration, robbing the atmosphere of oxygen. The one is in harmony with ventilation, the other antagonistic to it. The power to destroy disease germs which may be possessed by Condy's fluid is therefore precisely the same as that exerted by pure air.

Without needing to inquire into the *modus operandi* of ventilation—whether it be by oxidising and destroying the infectious emanations of the sick, or by acting on and removing the nidus or pabulum of disease germs, I feel confident that few, either among the advocates of chloralum, or the adherents of carbolic acid, will venture to dispute that, when sufficient, it is, in normal circumstances, an efficient means of natural disinfection. Those who are practically familiar with the uses of Condy's fluid, know that, as an artificial disinfectant, that preparation is almost to an equal degree efficacious. This, and not its mere want of odour, as Mr. Gamgee has been pleased to suppose, is "the secret" of that small measure of success which may have attended my labours of many years.—I am, &c.,

H. B. CONDY.

Battersea, January 23, 1871.

Dr. Wagner's Chemical Technology.— The eighth edition of Dr. Wagner's well-known work on "Chemical Technology" is soon to appear. An English edition of this valuable work is in preparation, and will be published shortly after the German edition.

CHEMICAL NOTICES FROM FOR EIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Pharmaceutische Zeitschrift für Russland, Nos. 10 and 11, 1870.

The only original paper relating to chemistry and allied sciences contained in these two numbers is the following:—

Researches on the Chemical Constituents of the Daphne Mezereum (Herb Laurel).—Dr. A. Casselmann.—Already noticed by us (see CHEMICAL NEWS, vol. xxii., p. 179), abstracted from another periodical.

No. 12.

Contains no original papers.

No. 13.

Contains a lengthy original essay on the—

Cellulose contained in Fungus.—Dr. E. Masing.—This exhaustive paper contains the following sections:—*Agaricus albus; Trametes suaveolens; Polyporus marginatus; Polyporus ignarius; Polyporus fomentarius; Russula alutacea; Polyporus albidus; Polyporus sonatus;* behaviour of the cellulose of fungus with various reagents; researches on the resin contained in fungus (*Boletus laricis*). This paper is too lengthy to admit of any useful abstraction, but it is a valuable contribution to the chemistry of cryptogamic vegetables.

No. 14.

Contains an original paper on—

Cumaric Acid, Hydrocumarine, and Hydrocumarinic Acid.—C. Zwenger.—This very lengthy essay treats, first, on the preparation of cumaric acid, $C_9H_8O_3$. This body is difficultly soluble in cold, somewhat more so in boiling water; crystallises in long needles; is readily soluble in ether and alcohol; fuses at 195°; may be sublimed by careful manipulation, but is decomposed by dry distillation, yielding chiefly phenol. The author describes at length a series of the salts of this acid, among which are the following:—Cumarate of barium, $(C_9H_7O)_2Ba+H_2O$, a crystalline substance which contains 1 molecule of water, which cannot be expelled by heat without decomposition of the salt; cumarate of lead, $(C_9H_7O_3)_2Pb$; cumarate of zinc, $(C_9H_7O_3)_2Zn$; cumarate of silver, $(C_9H_7O_3)Ag$. The second portion of this paper treats on hydrocumarine, and on hydrocumarinic acid; this latter body is a solid substance, difficultly soluble in cold, but more readily in boiling water; is crystalline; readily soluble in alcohol and ether. By the action of dilute acids, hydrocumarinic acid is converted into hydrocumarine, which is also formed when the acid is sublimed. The formula of hydrocumarinic acid is $C_{18}H_{16}O_6$; it forms, with bases, well-defined salts, many of which assume the crystalline form. Hydrocumarine is a solid crystalline body, which fuses at 222°, is almost insoluble in water, alcohol, and ether, and exhibits a neutral reaction to test-paper; it is best dissolved in chloroform, and yields, when treated with nitric acid, nitro compounds; its formula is $C_{18}H_{14}O_4$. The last portion of this essay treats at length on disalicyl-aldehyde, $C_{14}H_{10}O_3$.

No. 15.

Contains a lengthy paper on—

Cocculus Indicus and the Chief Constituents thereof, especially Picrotoxine.—W. Ganss.—This memoir contains the following sections:—Botanical and pharmacognostic description of the *Cocculus indicus*; on the use made of the berries; physiological action of the berries; general constituents of the berries (under this heading the author quotes the older analysis of this substance, made by MM. Pelletier, Couërbe, and others). The next section treats at length on the constituents of the berries, viz.:—Menispermine, $C_{18}H_{19}NO_3$, a solid crystalline body, which bears some resemblance to the bicyanide of mercury; it is a tasteless body, insoluble in water, but soluble in alcohol and ether; fuses at 120°; it is not, as far as experiments go, a substance which exerts any marked action upon animals. Paraspermine crystallises in quadrilateral rhombic prisms, fuses at 250°, and may be sublimed in sealed tubes; it is also insoluble in water, but readily dissolved by ether and absolute alcohol. Menisperminic acid, an as yet ill-defined body which, according to M. Boullay, exists in *Cocculus indicus*, but which neither M. Pelletier nor also M. Casaseca has found in that seed. Picrotoxine, discovered in 1812 by M. Boullay: The formula of this substance is, according to MM. Pelletier and Couerbe, $C_{18}H_{17}O_8$; while M. Oppermann gives to picrotoxine the formula $C_{15}H_6O_4$. The preparation of this substance from the berries is described by the author at great length; it may be briefly stated to consist in exhausting the previously pulverised berries with boiling alcohol, removal of the latter by distillation, taking up of the residue with boiling water, addition of a solution of acetate of lead to the aqueous extract, removal of the excess of lead from the filtrate by means of sulphuretted hydrogen gas, and re-crystallisation of the picrotoxine from the aqueous solution. Picrotoxine, in the pure state, is a crystalline body, which MM. Pelletier and Couerbe have called picrotoxinic acid, on account of its combining with oxide of lead forming a soluble compound therewith, which is, however, slowly decomposed by the action of the carbonic acid of the atmosphere. Picrotoxine acts as a sugar-containing body, reducing the hydrated oxide of copper, and assimilating, when boiled with dilute acids, water; it combines with bromine, $C_{21}H_{12}Br_4O_{10}$; with nitric acid it forms nitro-picrotoxine, $C_{21}H_{12}(NO_4)O_{10}$; and when distilled with caustic lime, it yields some metaceton. The larger portion of this paper is devoted to the exhaustive description of the physiological action of picrotoxine upon animals, which is continued in No. 16.

No. 16.

Contains no other original paper.

No. 17.

Contains a lengthy original essay on the—

Pharmacy of the Past (that is to say, a century and a half ago), and on the Present Condition thereof.—C. Frederking.

No. 18.

Contains an original paper on the—

Action, Nutritive Value, and Mode of Application of Extract of Meat.—Dr. E. Kemmerich.—The contents of this paper belong rather to the domains of physiology and therapeutics than to chemistry.

Zeitschrift für Chemie von Beilstein, No. 19, 1870.

The only original paper contained in this number is—

Acids which are Formed when the Hydrogen of Amides of the Toluol-Sulpho Acids is Replaced by Radicals of Acids.—Mdlle. Anna Wolkow.—This essay contains, in the first place, the statement that the amides $N(C_7H_7SO_2)H_2$ are, as far as their chemical behaviour is concerned, alcohols; in the second place, we meet with the description of the following substances:—Benzoyl-paratoluol-sulpho acid amide, $N[C_7H_7(SO_2)p](C_7H_5O)H$: This body is prepared by heating in an oil-bath, to a temperature of from 150° to 160°, a mixture of 33 grms. of paratoluol-sulpho acid amide and 28 grms. of chlorbenzoyl; the operation is continued as long as hydrochloric acid is given off. The reaction which ensues is represented by the formula—

$$N[C_7H_7(SO_2)p]H_2+C_7H_5OCl=N[C_7H_7(SO_2)p](C_7H_5O)H+HCl.$$

The resulting body is a crystalline substance, fusing at from 147° to 150°, readily soluble in boiling alcohol, but very difficultly so in cold alcohol, in ether, and in boiling water; this substance is an acid which expels carbonic acid from the carbonates of potassa, soda, lime, and baryta. The salts this acid forms with these bases are described, as is also the silver salt, $N[C_7H_7(SO_2)p](C_7H_5O)Ag$. Benzoyl-meta-toluol-sulpho acid amide, $N[C_7H_7(SO_2)m](C_7H_5O)H$, also a solid crystalline body, soluble in alcohol and ether, fusing at from 110° to 112°, this amide is also an acid. Several of the salts of this acid are described, and the lengthy formulæ thereof quoted. Succcinyl-paratoluol-sulpho acid amide, $N(C_7H_7SO_2m)(C_4H_4O_2)''$, prepared by heating 25·5 grms. of para-amide with 20·5 grms. of chlorsuccinyl first to 125° to 130°, and lastly to 150°. The result of this operation is the formation, in the first place, of monobasic acid, $N_2(C_7H_7SO_2p)(C_4H_4O_2)H_2$, readily soluble in boiling water, fusing at 180°. There is secondly formed a substance insoluble in water, a bibasic acid—

$$N_2(C_7H_7SO_2p)_2(C_4H_4O_2)H_2,$$

soluble in boiling alcohol, and crystalline. The salts and some of the products of the decomposition of these acids are described, accompanied with a series of very complex and lengthy formulæ.

No. 20, 1870.

The only original paper contained in this number is—

Question of the Existence of Antozone.—Dr. O. Loew.—This paper opens with an introduction containing a review of the various attempts made to explain the oxidising principle of oil of turpentine, and also the quotation of the leading ideas expressed on the nature of antozone. The author's chief object is to prove that the statement made by MM. Engler and Nasse (*Ann. Ch. Pharm.*, May, 1870), setting forth that antozone should simply be gaseous peroxide of hydrogen, is not quite correct. The results of a series of experiments made by the author, and described at great length, lead to the following conclusions:—(1) That the active principle in oil of turpentine is not ozone; because, when that body is shaken up with water, it does not yield peroxide of hydrogen. (2) That principle is, also, not peroxide of hydrogen; because, when an acid is not present, no reaction of iodine ensues (viz., when in contact with an alkaline iodide), while the formation of an acid in the oil of turpentine only takes place very slowly, and after considerable length of time. (3) There appears to exist a peculiar modification of oxygen which, when in contact with water, yields peroxide of hydrogen. This last modification of oxygen the author presumes to exist in the condition of free atoms, and he quotes the following formulæ for the various modifications of oxygen:—

[O].	[OO].	[OO]O.
Antozone.	Ordinary oxygen.	Ozone.

The active properties of oil of turpentine are explained by the author to be due to the presence in the oil of that kind of atomistic (*atomistischer*) oxygen, which we name antozone, being contained in the oil more in a state of physical than chemical combination, and, moreover, combined, or, at least, enveloped with heat (caloric). In a foot-note, the author states that, when pure oil of turpentine is left exposed to

sunlight for several weeks in a sealed tube along with dry oxygen gas, water is formed, which is observed in drops on the sides of the tube; it appears, also, that the oil alluded to, when in contact with water, yields directly peroxide of hydrogen.

No. 21, 1870.

This number contains the following original papers and essays:—

Dinitrobenzoic Acid.—D. Muretow.—The author prepares this acid by heating 100 grms. of nitrobenzoic acid with a mixture of 300 grms. of fuming nitric acid (sp. gr. = 1·48 to 1·49) and 600 grms. of oil of vitriol; the temperature should be about 140°. After having been purified, the dinitrobenzoic acid is obtained as a crystalline body, rather difficultly soluble in cold water, more readily so in boiling water; alcohol dissolves this substance easily. Dinitrobenzoic acid fuses at about 203°; it forms, with baryta and oxide of silver, crystallisable compounds. The formula of the former salt is $Ba[C_7H_3(NO_2)_2O_2]2+5H_2O$; that of the silver salt is $AgC_7H_3(NO_2)_2O_2$. Both these salts explode on being heated. By the reduction of dinitrobenzamide, the author prepared diamido-benzamide—

$$NH_2.C_7H_3(NH_2)_2O,$$

and describes several compounds thereof.

Azobenzol-Sulpho Acid.—Dr. Skandarow.—The body alluded to is prepared by heating azobenzol with 5 parts of strong fuming sulphuric acid (so-called Nordhausen acid); the substance thus obtained is a solid, orange-coloured, crystalline, and difficultly soluble in water. The potassa salt of this acid also crystallises; its formula is $C_{12}H_9(KSO_3)N_2+2H_2O$. The chloride of the azobenzol-sulpho acid is prepared by heating the potassa salt, previously dried at 165°, with pentachloride of phosphorus; this chloride is insoluble in cold water, and, by being boiled with that liquid, is slowly decomposed (viz., the chloride) into HCl and azobenzol-sulpho acid. The formula of the chloride is $C_{12}H_9(SO_2Cl)N_2$. The composition of the amide of the azobenzol-sulpho acid is $C_{12}H_9(SO_2.NH_2)N_2$.

Notices.—P. Alexejeff.—Under this title, the author quotes several minor matters, among which are the following:—Azonaphthaline and Nitrophthalen.—The percentical composition of the former is C, 85·12; H, 4·96; that of the latter, C, 85·1; H, 4·8. The only difference between these two bodies is that sulphuric acid colours azonaphthaline red, and the other blue. Bromated acetylen may be prepared by adding to solid sodium alcoholate, placed in a flask, drop by drop, $C_2H_2Br.Br_2$; the result is the formation of a spontaneously-combustible gas, which is to be collected over mercury, while the generation of acetylide of copper is readily exhibited by introducing into the gas a strip of paper moistened with a solution of ammonio-chloride (proto) of copper.

Hydrates of Oxychloride of Magnesia.—Dr. C. Bender.—This essay contains the results of a series of researches made with the view to elucidate the scientific principles involved in the formation of the so-called Sorel magnesia cement. The author describes at length the following substances:—$(MgCl_2+5MgO+17H_2O)$; that is to say, a piece of the cement alluded to, which had been made six months previous to the analysis, and had become quite hard. If this substance is treated with water, a portion of the chloride of magnesium is eliminated, and there remains, after drying over SO_3, a compound, $(MgCl_2+9MgO+24H_2O)$. By being treated with boiling water, this compound is entirely deprived of its chloride of magnesium, and there remains, after drying over SO_3, a hydrate of magnesia, $(2MgO+3H_2O)$. All these compounds are as hard as good sandstone, take a good polish, and are not disintegrated even by boiling water.

Hydrate of the Nitrate of Oxide of Uranium.—C. Schultz-Sellack.—While evaporating the solution of the nitrate alluded to with a large excess of nitric acid, the author obtained, on cooling, beautifully-fluorescent crystals, $UONO_3+1\frac{1}{2}H_2O$, or $2UONO_3+3H_2O$.

The Hydrate of Chloracetic Aldehyde.—G. Glinsky.—The author describes, at great length, the preparation of this substance, which is a rather complicate proceeding. The formula of the hydrate alluded to is $C_2H_2ClO+\frac{1}{2}H_2O$. It is a solid body, which fuses at between 64° and 65°; is volatile when exposed to air, becoming simultaneously oxidised; in dilute state, it gives off a smell of rotten apples, and, when concentrated, its vapours are very irritating, while it burns the skin of the hands like nitric acid; it reduces ammoniacal silver solution.

Gmelin's Work on Chemistry.—Dr. K. Kraut.—From a short notice of the editor of this periodical we learn that the author just mentioned has edited the few of the hitherto unfinished parts of Gmelin's work, including an excellently-arranged and very complete general index. The publisher is M. K. Winter, at Heidelberg.

NOTES AND QUERIES.

Amount of Tannin in Valonia.—The present prices of valonia are as follows:—Greek, £14 17s. 8d. per ton; Smyrna, £16 18s. 10d. per ton. I have recently examined three specimens of each kind, sold as first quality, and I find that the average amount of gallotannic acid in Smyrna valonia is 31·60 per cent, and in Greek valonia 31·12 per cent. Why is there so great a difference in the price of the two varieties?—CHARLES A. CAMERON, M.D., Dublin.

Solubility of Tin in Nitric Acid.—A friend of mine, a gentleman of undoubted scientific eminence, whom I met just this morning in the street, has informed me that Proust mentions the fact of the solubility of tin in "very dilute nitric acid with the production of nitrate of ammonia." I therefore renounce all claim to the discovery, so far as regards mere priority. There is, however, one circumstance in which my discovery differs from that of Proust; viz., that the acid employed by him was very dilute, while mine was very strong, being a mixture of equal volumes of the monohydrated acid and water. To speak as Mr. Gibbins does of the "evolution of ammonia" in presence of nitric acid is simply to talk nonsense, and to say that such a result "might have been expected" is to make nonsense more nonsensical. Honour to whom honour is due—I yield to Proust; although certainly for me the discovery was as real as if Proust had never existed; indeed, I have not yet seen his book or paper.—GEORGE HAY.

Solubility of Tin in Nitric Acid.—Mr. Hay has asked any of your readers to point out where it has already been mentioned that tin is soluble in nitric acid. In most of the modern text-books on chemistry, the action of nitric acid is described as being confined to the production of stannic oxide; however, in the tenth edition of Henry's "Chemistry" (1826), a statement is made which appears to show that it was known that, under certain conditions, tin is soluble in nitric acid. It will be better to transcribe the whole passage, which is taken from vol. ii., p. 43:—When nitric acid, highly concentrated, is poured upon tin filings, very little effect is produced; but when a small quantity of water is added, a violent effervescence follows, and the metal is reduced to a bulky powder, which is the white oxide retaining a little acid. If more water be added, an acid liquor is obtained holding very little tin in solution, and containing nitrate of ammonia, the alkaline base of which is formed by the simultaneous decomposition of the water and nitric acid, and the union of the hydrogen of the former with the nitrogen of the latter. Tin, however, is slowly dissolved, without effervescence, in nitric acid greatly diluted. The solution is yellow, and deposits tin by keeping." The two last sentences will, I think, be a sufficient reply to Mr. Hay. His attention may also be drawn to a paper by Mr. John M. Ordway, in the *Chemical Gazette*, vol. xv., p. 427, where it is stated that "if flattened tin be put into very weak nitric acid, say of sp. gr. 1·15, a small quantity is quickly taken up, but, in a short time, is thrown down again as a white powder containing no nitric acid." It is very likely other quotations of a similar kind could be found here and there in the periodical literature, and, if omitted from the more modern text-books, it is, perhaps, owing to ignorance of the most favourable conditions for the solution to take place. In regard to the occurrence of ammonia during the action of nitric acid on tin as noted by Mr. H. B. Gibbins, the above quotation from Henry will show that it has already been observed. The same fact is mentioned by Muspratt (see article on "Tin," vol. ii., p. 1037).—EUREKA.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 30th.—Medical, 8.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology. (Educational Course.)
TUESDAY, 31st.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
WEDNESDAY, Feb. 1st.—Society of Arts, 8.
—— Pharmaceutical, 8.30. Dr. W. B. Carpenter, F.R.S., "On the Microscope and its Revelations."
THURSDAY, 2nd.—London Institution, 7.30. Mr. F. S. Barff, M.A., F.C.S., "On the Action, Nature, and Detection of Poisons."
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Chemical, 8. Dr. Frankland, "On the Development of Fungi in Potable Water."
—— Royal, 8.30.
—— Royal Society Club, 6.
FRIDAY, 3rd.—Royal Institution, 9. W. Spottiswoode, F.R.S., "Some Experiments on Successive Polarisation of Light made by Sir C. Wheatstone."
—— Geologists' Association, 7.30. Anniversary.
SATURDAY, 4th.—Royal Institution, 3. Rev. W. H. Channing, "On Laws of Life Revealed in History."

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Student.—The editor is engaged on a work on the subject you name; it will shortly be published.

E. W. T. Jones.—Your letter has been referred to the secretary of the Chemical Society, who will, probably, send you the information.

R. Thomson.—You will find full particulars in our last Student's Number, published in September.

J. Mercer.—Mr. Baldwin's book you can obtain through your bookseller; the publishers are Brown and Nolan, Dublin. The other book you must order from a foreign bookseller.

W. H. Wood.—The experiments on the "Synthesis of Indigo-Blue" are not yet completed; we shall give full particulars as soon as the experiments are published.

F. H. T. A.—Dussauce has written a work "On Soap and Candle Making," in which fats and oils are fully treated of. It is at the library of the Commissioners of Patents.

W. M. Watts.—Received.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 584.

ON THE

SPECTRUM OF THE BESSEMER FLAME.

By W. MARSHALL WATTS, D.Sc.

A RECENT number of the CHEMICAL NEWS contains a paper by Mr. J. Spear Parker, in which he gives reasons for doubting the theory, maintained in the previous numbers by Mr. J. M. Silliman, that the lines of the Bessemer spectrum are caused by manganese, and not by carbon. Mr. Silliman says, "Lichtenfels, by a series of simultaneous comparisons of the manganese with the Bessemer spectrum, found the lines in the blue and green fields to completely harmonise in the two spectra." I am not acquainted with the research by Lichtenfels referred to, but, if such a coincidence has been established, manganese must be capable of giving two quite different spectra, since it is impossible to conceive spectra more widely different than the Bessemer spectrum and the spectrum of manganese as given by Huggins and Angström. The brightest lines of the manganese occur just in the part of the spectrum in which, according to Mr. Silliman's own observations, no lines are given by the Bessemer flame.

I can confirm Professor Lielegg's statement, that the Bessemer spectrum is produced also when coke is burned in the converter. I have never failed to see it, either in the first "blow" after re-lining, or at any other time.

Further, the Bessemer spectrum, with all its principal lines (though not very brilliant), can be obtained by burning coke with a blast of air in a re-heating furnace not containing iron or iron-slag; it is incredible that, in this case, the spectrum should be produced by manganese. In view of this observation, and the observation of Mr. Parker, there cannot, I think, remain the faintest hesitation in attributing the Bessemer spectrum to carbon or some carbon compound.

Mr. Silliman quotes from my paper on the Bessemer spectrum, but attributes it to Professor Roscoe. I desire to explain that Professor Roscoe is in no way responsible for any of its statements, and in particular for the statement that the hydrogen line occurs, at times, as an absorption-band.

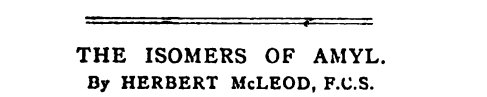
I do not remember ever observing the flame without seeing the sodium line momentarily as an absorption-band.

The occurrence of the three iron lines in the Bessemer spectrum, which Mr. Silliman does not consider has been satisfactorily established, is the one most certain result of my experiments. In an actual comparison of the Bessemer spectrum with the spectrum of the electric spark between iron poles in hydrogen, these three lines were observed to be absolutely coincident in the two spectra; and in a second simultaneous comparison of the Bessemer spectrum with that of sunlight, these lines were seen to be coincident with Fraunhofer lines marked by Kirchhoff as due to iron.

THE ISOMERS OF AMYL.

By HERBERT McLEOD, F.C.S.

NOTWITHSTANDING Mr. Loew's reply to my criticism of his previous communication, I still adhere to the opinion that his two formulæ, Nos. 4 and 9—



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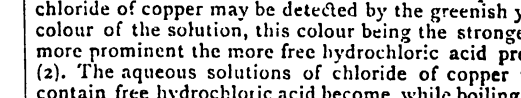


are identical; that is, they are so if the four atoms of hydrogen in marsh gas are of equal importance. If these atoms are of different values, then Mr. Loew's estimate of the number of the isomers of amyl is very much too low; for, as I endeavoured to show, the number of ethyls is at least thirty, on the assumption that the four attractions of carbon differ from one another (which is the same in effect as assuming the four atoms of hydrogen in marsh gas to be of different values), consequently, the number of isomers of amyl would be enormously larger.

Mr. Loew insists that in his two formulæ the three atoms of carbon, each of which is united to three atoms of hydrogen, are in different positions; but this differentiation seems merely a typographical one. In chemical compounds, we can only form a notion of the positions of elements from the manner in which they are combined amongst themselves, and not from the way we may please to write them on paper; this would be a lamentable abuse of chemical formulæ. But these three atoms of carbon are in perfectly similar positions, each being united to three atoms of hydrogen, and all of them with the same atom of carbon, this last atom being united to CH_2. This description is equally applicable to the two formulæ, notwithstanding their apparent dissimilarity.

Mr. Loew points out that M. Lwow, of St. Petersburg, has obtained an isomer of amylic hydride, by the action of the iodide obtained from trimethyl-carbinol on zinc methyl, and suggests that another isomer would probably be obtained by treating the chloride of aceton with zinc methyl. But, if these two hydrides were found to be identical, what would become of Mr. Loew's argument? A few clearly-established isomerisms of this kind would go far to show that the four attractions of carbon are of different values; but, until such is proved to be the case, chemists may be excused from further complicating their formulæ by labelling the four atoms of hydrogen in marsh gas.

In conclusion, either Mr. Loew believes that the four attractions of carbon are of equal value, in which case he has over-estimated the number of isomers of amyl, eight only being possible; or he believes they have different values, in which case he has enormously under-estimated their number, and I will gladly leave the calculation in his hands.

Royal College of Chemistry, London,
Jan. 24, 1871.

NEW VOLUMETRIC METHOD FOR THE ESTIMATION OF COPPER.*

By M. F. WEIL.

THE well-known fact that there has been hitherto no thoroughly reliable method for the estimation of copper in ores and alloys, and also when mixed with other metals, which interfere with the estimation of the copper, induced me to seek for a mode of operation which answers well in practice and is readily executed. It is as follows:—

The principles upon which my method is based are:—(1). That with an excess of free hydrochloric acid, and at boiling heat, the presence even of the smallest quantity of chloride of copper may be detected by the greenish yellow colour of the solution, this colour being the stronger and more prominent the more free hydrochloric acid prevails. (2). The aqueous solutions of chloride of copper which contain free hydrochloric acid become, while boiling, upon the addition of protochloride of tin, instantaneously converted into colourless solutions of protochloride of copper, according to the formula $2CuCl + SnCl = Cu_2Cl + SnCl_2$. The reaction is quite finished as soon as, by the addition, drop by drop, of the protochloride of tin, the green colour of the perchloride of copper is changed to the colourless

* Communicated by the Author.

protochloride of copper. Even a single drop of the protochloride of tin added in excess can be readily detected by the addition of a single drop of a solution of corrosive sublimate, which produces a precipitate of white protochloride of mercury. It is clear, therefore, that the quantity of the solution of protochloride of tin which is required for the perfect decolouration of the copper solution will indicate the quantity of the copper present in the solution, which, if it contains iron along with the copper, the iron will have to be estimated in a separate portion of the solution by means of permanganate of potassa; while, in the estimation of the copper, the quantity of protochloride of tin, equivalent to and converted by the iron into perchloride of tin, has to be deducted.

I. *Preparation and Keeping of the Solution of Protochloride of Tin.*—Take about 6 grms. of tin-foil (this material ought first to be tested for its purity), dissolve in 200 c.c. of pure hydrochloric acid at a boiling heat, and with the addition of some pieces of platinum wire; the tin solution thus obtained is diluted to 1000 c.c. by the addition of distilled water, and is poured into a wide-mouthed glass bottle, after which the solution is covered over with a layer of petroleum. This bottle is provided with a glass syphon-tube and stop-cock attached, and also with a funnel-tube for replenishing the solution, which, although kept under petroleum, and thereby protected from the action of the air, only keeps sufficiently steady and unaltered for a single day, so that the liquid has to be tested and accurately titrated every morning before using it for the estimation of copper in solutions wherein the quantity of that metal is unknown.

II. *Titration of the Protochloride of Tin for Pure Copper.*—Take chemically pure, re-crystallised, pulverised sulphate of copper deprived of adhering moisture by pressing between filtering-paper; weigh off 7·867 grms. (equal to 2 grms. of pure metallic copper), dissolve in distilled water, and dilute to 500 c.c.; keep this solution as normal solution of copper in a glass-stoppered bottle. Take of this solution, by means of a pipette, 25 c.c. (equal to 0·1 grm. of pure copper); pour this quantity into a flask capable of containing 100 c.c.; add 5 c.c. of pure hydrochloric acid, which causes the blue fluid to become deep green; and next boil the liquid upon a sand-bath; then take a burette, divided into c.c. and 1-10th c.c., fill it with the solution of protochloride of tin up to zero, and immediately after pour rapidly into the boiling copper solution sufficient of the tin salt to cause the same to become very nearly decolourised. After this, the tin solution is added, drop by drop, until the copper solution is as clear and colourless as distilled water is; as soon as this point has been reached, add with a pipette again 5 c.c. of pure hydrochloric acid, and, if by this addition the slightest green colouration is produced, protochloride of tin is added, drop by drop, until the decolouration is complete; after this, the quantity of tin solution employed is read off. If it is desired to make sure that the end of the reaction is properly reached (a precaution which is quite unnecessary if 10 c.c. of hydrochloric acid have been added), 1 c.c. of the colourless solution is taken, by means of a pipette, and poured into a test-tube; this tube is placed in cold water, to promote the rapid cooling of the contents; and, after cooling, there is added to the solution one drop of a concentrated aqueous solution of chloride of mercury. If this does not bring about a turbidity or precipitate, it is best to add to the contents of the flask another drop of protochloride of tin solution; this having been done, the testing of the contents of the flask by means of chloride of mercury, as just mentioned, is repeated; and if a turbidity or precipitate ensues, the quantity of tin solution applied is read off, care being taken to deduct therefrom 1·20th of a c.c. Every 16·2 c.c. of the tin solution correspond to 0·1 grm. of metallic copper.

III. *Example of Titration of any Compound of Copper not containing either Iron or Nickel.*—Take 4 grms. of the metal, either reduced to powder, or at least cut (not filed) to a convenient size; dissolve in strong nitric acid contained in a long-necked flask; expel the excess of this acid by boiling with excess of sulphuric acid, or with hydrochloric acid, in case silver is contained in the substance taken for assay; next, water is added, and the bulk of the fluid brought to from 250 to 500 c.c., according to the presumable quantity of copper present, care being taken to mix the liquid thoroughly, and thereby render it uniform throughout. It is not absolutely required to remove by filtration insoluble substances, such as silica, sulphate of lead, stannic acid, antimonic acid, chloride of silver, and the like, since these substances settle readily to the bottom of the tall cylindrical jar employed for containing the liquid, while the assay is being made. The tin solution is added after the addition, as above stated, of some 5 or 10 c.c of hydrochloric acid. Example:—Two grms. of an alloy containing much copper were made into a solution of 250 c.c.; 25 c.c. thereof having been taken for assay required 25·42 c.c. of protochloride of tin solution, of which 16·2 c.c. corresponded to 0·1 grm. of pure copper. The 25 c.c. of the solution of the alloy taken for assay contain, therefore, 0·1569 grm. of copper, because 16·2 : 25·42 = 0·1 : 0·1569; consequently the quantity of copper contained in 250 c.c. is = 1·569 grm., because 0·1569 × 10 = 1·569; and therefore 100 grms. of the alloy contain, according to the following equation:—

$$1{\cdot}569 \times 50 = 78{\cdot}45 \text{ per cent of copper.}$$

IV. *Titration of a Compound of Copper which also contains Iron.*—The weighing off of the substance, its solution in acid, and the titration of 25 c.c. of the joint solution of the two metals, is performed as described under III., with this difference, that the operation of adding the tin solution is performed with the solution of the metals contained in a flask of a capacity of at least 250 c.c. After the total quantity of tin solution required at the first titration has been noted, the titration of the iron is executed in the following manner:—Some 25 or 50 c.c. of the sulphuric acid solution are diluted with a large quantity of water, and placed in a flask of 250 c.c. capacity; to this liquid, metallic zinc and platinum wire are added, and left in the solution until it is perfectly colourless; the entire quantity of copper, tin, lead, arsenic, antimony, &c., which might be present is precipitated in the metallic state; the colourless fluid is then decanted, and the iron volumetrically estimated by means of permanganate of potassa. Since perchloride of iron, as well as the chloride of copper, are reduced by protochloride of tin, according to the following formulæ—

$$Fe_2Cl_3 + SnCl = 2FeCl + SnCl_2, \text{ and}$$
$$2CuCl + SnCl = Cu_2Cl + SnCl_2,$$

it is evident that the quantity of protochloride of tin which corresponds to the iron is found by simple calculation from the experiments made, as will be best illustrated by the following example:—Four grammes of a copper ore, which also contained iron, were dissolved, and the solution made to 250 c.c.; of this solution, 25 c.c. were taken for assay, and found to require 26·75 c.c. of protochloride of tin solution of 16·2 litre. By titration with permanganate of potassa, 25 c.c. of the solution under assay were found to contain 0·0809 grm. of iron. The protochloride of tin solution employed corresponds with 18·34 c.c. for 0·1 grm. of iron; therefore—

1 equiv. copper : 1 equiv. iron = copper : × iron.
31·7 : 28 = 0·1 : 0·0883.

Consequently, 0·1 grm. of copper corresponds to 0·0883 of iron, and likewise to 16·2 c.c. of protochloride of tin; on the other hand, 0·1 grm. of iron corresponds to 18·34 c.c. of protochloride of tin, because 0·0883 : 0·1 = 16·2 : 18·34 c.c. protochloride of tin; therefore, again, 0·0809 grm. of iron requires 14·837 c.c. of protochloride of tin, because 0·1 : 0·0809 = 18·34 : 14·837.

Calculation of Results.

	Protochloride of tin. c.c.
For copper and iron together	26·750
Deduct for iron alone	14·837
Leaves, for copper..	11·913

25 c.c. of the solution therefore contain 0·0735 grm. of copper, because 16·2 : 0·1 = 11·913 : 0·0735. 4 grms. of the ore = 250 c.c. contain, accordingly, 0·735 grm. of copper, and 100 grms. of the ore contain, therefore, 18·38 per cent of copper.

Observation on the Titration of Compounds of Copper containing Iron.—If the operator does not happen to have ready at hand a titrated permanganate solution for the estimation of the iron, the titration of the fluid containing copper and iron can be readily performed in the following manner:—Precipitate, as above mentioned, by the aid of zinc and platinum, all the copper, &c.; decant the supernatant fluid; wash the precipitated metal (or metals) with distilled water, and dissolve these in sulphuric acid; and estimate, next, in 25 c.c. of that solution (after previous addition of from 5 to 10 c.c. of pure hydrochloric acid), by titration with protochloride of tin solution, the copper directly without the necessity of determining the iron at all.

V. *Titration of a Compound of Copper which contains Nickel.*—Since the green colour of the salts of nickel prevents the complete and perfect decolouration, by protochloride of tin, of a solution which contains copper and nickel together, the titration by means of the tin salt, as described, can be applied, but the end of the reaction must be tested for by the use of the solution of corrosive sublimate. In preference, however, to this I employ the following method:—The substance to be tested (about 4 grms.) is dissolved in nitric acid, or, if need be, in nitro-hydrochloric acid; next, the greater part, but not all, the acid is saturated with carbonate of soda; then add, after having diluted the fluid with cold water, an excess of freshly-precipitated carbonate of baryta, to which some chloride of ammonium is added, and which together are suspended in water. This milky fluid is thoroughly stirred through the metallic solution; by this proceeding, a precipitate ensues, which contains all the copper as hydrated oxide and (if present) the iron also as hydrated oxide, while the nickel remains in solution. The precipitate is first washed by decantation, next collected on a filter, thoroughly washed, and, after having been re-dissolved in hydrochloric acid, titrated as above described. The presence of arsenia or its compounds does not in the least interfere with the process; while, if cobalt happens to be present, which will, however, be only rarely the case, the treatment is the same as for nickel. By a series of test experiments, and by comparison with gravimetrical analysis, the author states that he has found the process above described to be thoroughly reliable and to give accurate results.

ON THE CHEMISTRY OF THE BESSEMER PROCESS.

THE following is an abstract of the paper on the chemistry of the Bessemer process, read before the American Association for the Advancement of Science, at its Troy meeting, by Lieut. C. E. DUTTON, U.S.A.:—

After some general statements concerning the chemical composition of crude pig-iron, Lieutenant Dutton passed to discuss the theoretical changes possible when air is brought in contact with it in a melted state. According to his view, the silicon is first oxidised, then the phosphorus, next the manganese and sulphur, and, lastly, the carbon. Chemically, there is nothing new in the Bessemer process. It may be said to be "the employment of entirely new mechanical methods and appliances for effecting old and familiar reactions."

The process itself was then minutely described. Since the sulphur is but partially removed and the phosphorus not at all, the iron selected must be free from these substances. It must also contain at least two per cent of silicon. This iron is melted in a cupola furnace, run into the converter—a charge being 12,000 pounds—and the blast turned on. "The first change is in the oxidation of iron and silicon. The silicon becomes silicic acid, and enough of the iron oxidises to satisfy the affinities of the acid, and does not decompose during the remainder of the blast. It is during this stage of the conversion that the remarkable heat of the conversion is developed. It will be remembered that when silicon oxidises, it takes up three equivalents of oxygen. Carbon takes up only one in this process, becoming carbonic oxide. It is a common error to suppose that any very great quantity of heat is generated by the combustion of the carbon, that is, as compared with that derived from the silicon. . . . . The heat generated by the silicon burning to silicic acid will be found, by the application of the coefficients and formulæ of the mechanical theory of heat, to be from two and a-half to three times greater than that generated by the burning of the carbon to carbonic oxide. Another circumstance of importance is that the silicic acid remains as a dense fluid in the converter, no part of its heat being lost, except such as is carried out of the converter by the atmospheric nitrogen; and none is rendered latent by converting it into vapour, while the carbon is vapourised, a physical change absorbing much heat, and the vapour thus formed is carried out of the converter at a very high temperature. Hence will be seen the necessity of employing irons containing high percentages of silicon. At least two per cent of this element is essential, any less quantity being insufficient to generate heat enough to keep the iron thoroughly liquid and fluent until the end of the casting process. It is often asserted that irons for Bessemer conversion must be 'grey irons,' as they are called, *i.e.*, irons rich in carbon. Now, although this happens, as a rule, to be true enough, it is apt to lead to misapprehension. The fact that Bessemer pig-irons are carbonised varieties is an accident, and not an essential feature. What is essential is that it should contain a large quantity of silicon, and very little—indeed, the least possible—of sulphur, phosphorus, and manganese. Now, a pig-iron containing much silicon and no sulphur, or manganese, is pretty sure to contain a high percentage of carbon, as all smelters are aware. This fact is a feature of the blast-furnace, and almost without exception. If an iron could be produced with much silicon, a little carbon, no phosphorus, it would, I think, be not altogether unsuited to the Bessemer treatment. In a word, the quantity of carbon is approximately immaterial, except so far as it implies proper conditions with respect to other elements. The main element required is the silicon and not the carbon."

Of phosphorus, "the arch-enemy of the iron-maker, but the very scourge and pestilence of the steel-maker,"—fifteen thousandths of one per cent ruining Bessemer metal past all remedy—Lieut. Dutton said:—"I have already ventured the opinion that phosphorus increases its affinity for iron with every increase of heat; at least relatively if not absolutely. The fact seems to be absolutely. If we accept it, we can instantly explain what seem, otherwise, to be many anomalies and contradictions. It will explain to us why, in the great heat of the blast-furnace, it leaves every other combination and enters the iron; why, in the much lower heat of the puddling furnace, it seems to waver between staying with the iron, or forming a new alliance with oxygen, ready to choose either, at the influence of any third substance which may affect the question; why in the Bessemer process it clings to the iron with a desperate tenacity which nothing seems able ro resolve. These three facts, then, are all of them formidable: (1) that a minute quantity of phosphorus is capable of working

terrible injury, and that it is omnipresent throughout nature; (2) that whatever quantities of it are charged into the blast-furnace, as fuel, flux, or ore, are almost wholly concentrated in the resulting pig-iron; and (3) that no portion is eliminated in the Bessemer converter."

The sudden change of the flame at the close of the conversion Lieut. Dutton thus explained:—

"When two combustibles are intermixed, like oxygen and hydrogen, or hydrocarbon gas, it is well known that the relative proportion of the two elements in the mixture influences the readiness with which they combine. Thus oxygen and hydrogen cannot combine explosively unless their proportions lie within certain definite and rather narrow limits. May not the same law hold good in the present case? It is certain, or nearly certain, that the iron either does not oxidise in the bath during the blow, except in quantity sufficient to furnish a base for the acids present; or, if it oxidises beyond that, it is immediately reduced again, leaving little or no free oxide of iron in the bath. But after the change of flame all this is reversed, and iron oxidises rapidly and freely, and remains undecomposed, while the residual traces of the other elements as suddenly cease to oxidise rapidly. I freely grant that in referring this back to what is supposed to be a conceded, but unexplained law, we are merely putting the question in another, a more general, and more abstract shape—still it is, in a qualified sense, an explanation."

The theory of the action of the spiegeleisen, run in after the blast is stopped is next discussed, and also the quality of the metal produced, which Lieutenant Dutton calls a "cast wrought-iron."

The paper closed with some comparisons of Bessemer with other metal, and a discussion of the uses for which Bessemer metal is most valuable."

AN EXAMINATION OF GROVE'S ARGUMENT FOR AN INVARIABLE MECHANICAL EQUIVALENT OF HEAT.

By the Rev. H. HIGHTON, M.A.

In his "Correlation of Physical Forces" (ed. 1867), Grove urges the following argument for an invariable mechanical equivalent of heat. Not having his book at hand while I write, I give his argument in my own words, but I believe with perfect fairness.

If, says he, two different gases by the application of equal quantities of heat could raise different weights, we should have the following anomaly. Suppose "a definite source of heat (say a pound of mercury at 400°)" were applied to each of two gases, each working a piston, and they were to be set to work one against the other; then, if they exerted unequal pressures, the one must expand and compress the other; consequently, the one which was compressed must evolve heat, and would by such evolution of heat raise the heat of its pound of mercury to, say, 401°. Thus, says he, we should have the anomalous result that one pound of mercury at 400°, could raise another pound from 400° to 401°.

This I believe to be a perfectly fair representation of his argument.

In answer to this, let me observe, that if one gas or vapour when expanded by a given amount of heat will raise 10 lbs., while another by the same amount of heat will raise only 1 lb., and if this be a real fact, a fact established by our best experimenters in observing the specific heat, and rate of expansion, and elasticity of vapours and gases, it cannot be the slightest use to raise theoretical and imaginary difficulties to prove, theoretically, that such a fact is impossible. Theories must be squared by facts, not facts by theories.

But let us see the fallacy of the argument.

To say nothing of the fact that a pound of mercury at 400° cannot strictly be said to be "a definite source of heat," that is, the source of a definite amount of heat, without knowing the circumstances of the body with which it is to be brought into contact, Grove seems to suppose that the first pound of mercury heats and expands a gas or vapour without losing any of its own heat. He supposes it still remains at 400°. But if it sinks to 398° in expanding and heating the gas to which it is applied, what anomaly, or even difficulty, is there in supposing that while it sinks to 398° it may raise another pound to 401°?

It is just what we should expect. Steam at 100° C., condensed in a solution of chloride of calcium will raise it to a much higher temperature than 100°.

Now, here is another nut to crack for Mr. Grove, or any other advocate of an invariable mechanical equivalent of heat. Let him calculate the specific gravity, the specific capacity for heat, the expansion by heat, and the elasticity or compressibility of mercury and water. I think this calculation (unless I am much mistaken) will show that a given quantity of heat applied to expand mercury will raise seven times the weight that it will if applied to expand water.

The idea of an invariable mechanical equivalent of heat has taken such deep root in the scientific world, that it will not be easy to extirpate it; but till it is extirpated, together with the supposed axiom of conservation of energy as applied to mixed questions of mechanics and other sciences, it will be a continual stumbling block to true progress.

What is each individual life, vegetable or animal, but a centre for the evolution of force, by disturbing or restoring chemical, electric, calorific equilibrium, by burning and unburning; each of the two kinds of life, generally speaking, working against one another, the one undoing what the other does? And what limit is there to life? The only limit in nature to the production of motion (in the largest sense of the word) is that whatever amount of motion in a positive sense be produced, an equal amount must be produced of motion in a negative sense. But both may be utilised for work to subserve man's convenience.

Putney, Jan. 16, 1871.

HISTORY OF THE COLOURS PRODUCED FROM COAL-TAR.

By H. BOCK BINKO.

It is admitted in the scientific, as well as the industrial world, that the German chemist Runge, of Oranienburg, was the first to discover the production of colour from coal-tar, and the year of this discovery is 1837.

At a later period only, were English, French, and German chemists successful in producing the splendid aniline colours, which are hardly to be excelled anywhere.

We are indebted for aniline itself to Hofmann and Fritzsche since 1840. Aniline-violet was then produced by Perkin, and introduced into colouring in 1856, aniline-brown was discovered by Laire in 1861, aniline-orange by Mène in 1861, aniline-blue by Persoz, in 1862, aniline-black by Lucas, in 1863, aniline-green by Isébe, and aniline-brown by Nicholson.

Now followed year after year further discoveries. Aniline oils were produced and again aniline colour factories were erected, and at present it has been brought to such perfection that colours have been extracted from aniline, napthaline, and anthracene, and even from phenol, so that coal-tar colours may be counted by the dozen.

This production may seem surprising, but it is yet

exceeded by the fact that similar colours were discovered in 1816 by a single man, and had been practically applied by him in dyeing.

The compiler of these lines hopes that he will be able to throw a light on this important subject, and also to forward the writings of this great but unknown author, so that the world may be enabled to appreciate the proofs of his activity.

The *Neue Freie Presse* has taken notice of the same in No. 2005 (trade and industrial news). Even to-day this discussion is not by any means concluded, although that which has been already brought to light, may cause universal interest to be centred therein.

Johann Nepomuk Jassnüger, as this discoverer was named, wandered from his birthplace, Puchow, in the Trentschiner district, in Hungary, as a poor student to Vienna; obtained there, by dint of unexampled diligence, an excellent physical and chemical education; became doctor of medicine, and, from 1802, professor of chemistry at the Imperial Theresian Knight-Academy in Vienna, where he died in 1827. To the kindness of his son-in-law, the notary, Dr. Olschbauer, we are indebted for the few written notes from Jassnüger's own hand, and which great discovery will always remain preserved by him as private property.

They are as follows:—The first document relates to an application to the Chamber of Commerce for a patent.

"After many repeated and wearying chemical researches, the undersigned has been successful in extracting from coal and turf a substance for colouring, and not only galls, campeachy wood, sumach wood, and other materials necessary for colouring may be added to some foreign colouring materials, and also those used in the preparation of black inks. Still it is needless to add that all these articles may be entirely dispensed with through the above discovery.

"By means of this colour, extracted from coal and turf by the undersigned, it is possible to colour just as lasting and beautiful in less time and expense than is necessary to colour black, with the usual means, all sorts of wool, silk, cord (flax and hemp), prepared spun stuffs and cloth, all sorts of hats, whether made from beaver, hare, or rabbit-hair, or whether prepared from sheep's wool. This new colour, which the undersigned desires to give the name of Vienna black, has, besides the properties already described, one particular quality, that is, that the blue ground in colouring black substances can be dispensed with, by which means a very important quantity of indigo can be spared, and that the well-known prejudicial effect known under the name of burning, and which is noticed in the application of acids, is disposed of with reference to the above on the strength and lasting properties of cloths.

"Black ink can also, by means of this new colour, be prepared to the darkest tinge of black in a very cheap and quick manner without boiling. This ink has, then, the particular quality that mildew never settles upon it, and it thereby does not so soon become spoilt as in the case of the usual inks.

"But not only in black-colouring, but by all other colours where acids have been applied, is this colouring matter from turf and coal designed to take its place, but those substances used in the colouring of brown, green, and yellow tinges can be dispensed with.

"When, now, the undersigned ventures to remark important sums of money have to be paid away to foreign countries annually, for the so-much used acids in colouring, and likewise for other colouring substances, and when he, at the same time, considers that it has never occurred to any artist, colourman, or manufacturer to invent such an article that will be produced from turf and coal, thereby dispensing with the expensive foreign colouring substances, he is inclined to think with certainty that no person can doubt the usefulness and originality of this invention.

"The undersigned wishes this invention to become now universal. It is apparent that this wish might be speedily and safely realised by the undersigned publicly announcing his method of producing colour substance from coal and turf, as also the mode of application in colouring, but as the waste of time and money demanded by the necessary trials and researches for this invention is not to be reimbursed in the usual manner by attracting public attention, he is prompted to petition the worthy and honoured Imperial Chamber of Commerce to grant him the sole privilege of imparting this invention for the space of fifteen years to the entire Imperial Austrian monarchy, including the Hungarian and Italian provinces, namely, 'The production of colouring substance extracted from turf and coal, as applied to the colouring and preparation of ink, &c.'—(Signed) JASSNUGER, Vienna, May 24th, 1817."

The second document is a petition from Jassnüger to the City Provost. It runs:—

"In the decree of the 17th ult., Z. 45,790, it was announced to the undersigned by the honoured City Commandant, that his Imperial Majesty had agreed to grant him the exclusive privilege for eight years, for the extent of the entire monarchy, to impart the production of colouring matter under the name of Vienna black, on condition that he should make another sample and afterwards deposit an exact and likewise sealed description of his mode of producing the above with the high Commission sitting on Commerce.

"On the 28th ult. the undersigned had the honour to present this sample to the Commission sitting, and of showing its efficacy by trials that from coal this colouring substance is produced, and that not only can wool, silk, and cotton be coloured black, but also red, different sorts of yellow, brown-red, and violet, &c.

"The undersigned is prepared, for the purpose of obtaining the above sole right, to send in the sealed description, but as he has reason to hope, according to the declaration given in his protocol of the 28th ult., that the production of all colour substances from coal used in the preparation of colours and ink can be decidedly further extended, he is prompted to beg the City Provost to allow further details to stand over to allow of a more decided and closer description.—(Signed) JASSNUGER, Vienna, Dec. 17th, 1817."

Besides this, there is an original certificate of the council in the possession of the common councilman, Mr. Samuel Ritter von Lindemann, May 27th, 1818, in which it is stated that he attended Jassnüger on the 6th of April, 1818, in the Imperial Theresian Ritter Academy Laboratory, during the researches into the extraction and application of colour substance from coal; and the above-named Professor himself, in the presence of several persons, had extracted colour from coal, and had coloured silk wool with a brownish-black tinge, &c.

From these documents it will be seen that Dr. Jassnüger discovered the art of extracting black, brown, grey, sepia (?), yellow, red, brown-red, and violet from coal-tar. Green and blue are not mentioned. The exact dates, with reference to the effect of the colour on cloth, and of the quality of the ink from the new black, leave no doubt behind that we have really before us the first invention of "colours extracted from coal-tar."

There is also the fact that, in the application for a patent, it is mentioned that linen and hemp can be coloured by means of a substance extracted from coal-tar colour, and the same remarks are repeated. In latter periods it was discovered that silk and sheep-wool, as also cotton, hair, &c., may be coloured by means of aniline, but never in the same degree with regard to linen.

Through the machinations of his rivals, Prechtl and Jaquin, Jassnüger was obliged to carry the secret of extracting and the preparation of coal colours into his grave, for the above-named, through their eloquence, caused the Government to grant a patent only on the condition that they should be likewise informed of the secret, but (they being the bitter enemies of Jassnüger) this proposition was refused by him. In this manner the glory of Austria perished not only in seeing this colossal modern branch of industry fail to make the usual advance,

but also embittered the last days of the inventor in the joy and splendour of his discovery.

When my further researches are successful I shall have much pleasure in concluding the article.

January, 1871.

ON THE STEARIC ACID INDUSTRY.*

By J. LAWRENCE SMITH.

Saponification by Sulphuric Acid without Distillation.

Fats saponified by sulphuric acid by the ordinary method contain more or less tarry matter, arising from the decomposition of the fats, causing more or less loss in the raw material.

M. De Milly undertook a series of experiments, by which he finally showed that fats could be saponified by sulphuric acid without the formation of tarry matter. This point being established, he further showed that the fatty acids obtained without the formation of tarry matter were identical with the fatty acids formed by the lime saponification. These he submitted to cold and hot pressure under special conditions, and obtained cakes of candle stuff most beautifully white. As to the oleic acid, it is of a dark colour, but in no way decomposed; it makes a fine brown soap, or it can be distilled and made white.

M. Balard, in a report on this process, expresses himself in the following terms:—

"In the establishment of M. de Milly, the fat is melted and heated to 120° C.; it is then allowed to flow from its reservoir and mix with a stream of strong sulphuric acid, in the proportion of six per cent of the latter. The mixture is rendered perfect by means of agitation. The action takes place immediately, and is arrested in two or three minutes by allowing the mixture to flow into boiling water, when the sulphuric acid and unaltered glycerine enters into solution and the fatty acids float on the surface being of a dark colour. But, contrary to what takes place in the ordinary method of saponification by sulphuric acid, the colouring matter is completely soluble in the liquid fat acid, so that by cold and hot compression the solid fat acids are obtained perfectly white, ready to be moulded into candles. The entire operation can be accomplished in one hour.

"Nevertheless, it is preferable, when the cold pressure has furnished the solid acid but still coloured, to melt it again and put into the pans; then, on cooling, to submit it to all necessary pressure, when a fatty acid, fusible at 55° C. is obtained, admirably adapted for the very finest candles.

"It is readily seen that a certain portion of the solid fat acid will find its way into the liquid acid, as the crystallisable sugar in molasses; this can be submitted to distillation. Here, however, the distillation, conducted in such manner, only operates on less than one-fourth of the original solid fat, as the other three-fourths have been separated before the distillation. It is evident that the method unites the advantage of lime saponification and the process of distillation. Three-fourths of the acid obtained is fit for the best quality of candles, and the other fourth for a second quality. The yield of solid fat acids by this method, when properly conducted, is greater than by the other method of saponification with sulphuric acid, there being no loss by carbonisation."

This new process, which has been carried on for some time in the factory of De Milly, introduces an extreme simplicity into the stearic acid industry. All that is necessary to conduct the operation are a few receivers and two or three hydraulic presses, requiring but a small amount of capital. It is being introduced into various parts of Europe. M. De Milly has taken out a patent in this country, but as yet it has not been carried out practically. This process bids fair to take a high rank among the known processes for manufacturing candles.

Machinery Connected with the Manufacture of Candles.

There is nothing under this head exhibited worthy of special notice. Leon Droux showed a new form of autoclave for treating fat under pressure with water, but it appeared to the writer to be inferior to several forms now in used. Leroy and Durand exhibited a new still, in which there was nothing new except a method for regulating the temperature of the superheated steam. There was a square box inserted in the masonry acting as a recipient of two jets of steam, one highly superheated and the other from the steam boiler; both jets were regulated by valves that could be adjusted to admit more or less of one or other flows of steam, thus regulating in a very ready manner the temperature of the steam admitted to the still. Morane and others exhibited moulding machinery, but there was no new improvement on the already admirable machines for accomplishing this part of the manufacture of candles.

Oleic Acid from the Manufacture of Candles.

The employment of this acid formed a part of the original patent of Chevreul and Gay-Lussac, viz, to convert it into soap; but when the candle industry was first successfully conducted by De Milly and Motard, they found it impossible to dispose of the oleic acid to the soap makers, they being prejudiced against its use; so these manufacturers, in their unconquerable perseverance, converted it into soap themselves, and now a soap department is the natural adjunct to every candle factory. This acid is also employed to replace the oil used in the manufacture of woollen cloth, an application first suggested by Peligot and Alcan. Attempts have been made to procure elaidic acid (a solid oil acid) by the well-known reaction of hyponitric acid upon it, thus increasing the amount of fat which can be used in making candles; but, owing to the fact that this reaction produces a red substance that becomes mixed with the fat acid, the method has never found its way into industrial chemistry, and the solution of this question is left to future chemists.

Quality of Candles.

The following are some of the points to be noticed in forming a correct opinion of the quality of candles:—

1st. The nature of fatty matter used in their manufacture.
2nd. Their whiteness.
3rd. Their transparency.
4th. Their hardness.
5th. Their dryness to the touch.
6th. Their point of fusion.
7th. Their form and their moulding.
8th. The nature of the wick.
9th. The nature of the flame: if it be uniform, long or short, well supplied, illuminating, brilliant, with or without smoke.
10th. Does the cupping at the top of the candle burn dry, or is it more or less filled with melted fat?
11th. Is the fatty matter free from mineral substances?

The above list, as made out by Stas, gives all the points worthy of note to furnish a correct idea of the quality of candles. The point of fusion of the best quality of candles should not fall short of 55° C. The candles from palm oil acids, although giving very excellent light, seldom exceed 51° C., and often fall short of it, To obviate the disadvantages of using the more fusible candles some manufacturers now envelope them in a layer of material that melts at 56° C. This is done in moulding them; and, while it is advantageous, it is only an imperfect substitute for those made altogether of harder material. The candles made from distilled material give a whiter light than those from lime saponification, but are less fusible and colour more or less in contact with the air, for

* From "The Progress and Condition of Several Departments of Industrial Chemistry," by J. Lawrence Smith.

which reason the star candle from lime saponification ranks highest in commerce.

Soap.

Under this head nothing new was developed, except the use of oleic acid from the new method of De Milly, of saponifying fats by sulphuric acid without subsequent distillation. The detergent property of this soap is not inferior to that of any other, although the colour is very much darker. The manufacture of soap increases very rapidly, every day new factories springing into existence in all parts of the world. Marseilles still ranks first in the soap industry, although the inferior fats and oils are used more than formerly. We are indebted for the present condition of this industry to M. Chevreul, as well as for that of stearine candles, which now both go hand in hand, as the candle-maker must be a soap-maker to consume the excess of oleic acid which is formed in the manufacture of candles.

The different makers try to rival each other in the manner of making up the soap for market, both in appearance and size of separate masses. For the consumers the pound lump is more and more commonly used, and nowhere is the appearance of the soap attended to with more care than at the factory of the Barriére de l'Etoile, where De Milly first engrafted soap-making or star-candle making.

Conclusion.

To describe the machinery, and to give statistics of separate establishments which manufacture one or more products, would extend this report into several volumes.

The gigantic nature of some of these establishments, and their operations as now conducted, may be seen in the establishment of Messrs. Casthelaz and Co., of Paris. They decompose daily two tons of nitrate of soda by sulphuric acid to furnish the nitric acid they use for the purpose of producing the nitrogen compounds of benzol and toluol, for transforming arsenious into arsenic acid, phenic acid into picric acid, the bichloride of naphthaline into phthalic acid, &c. They transform daily a ton of benzol into nitro-benzol and aniline; they also make naphthaline for the purpose of producing benzoic acid, first forming phthalic acid from the bichloride of naphthaline. The phthalate of ammonia, distilled, gives phthalimide of lucuine; distilled with powdered lime, the phthalimide produces benzonitrile, and benzonitrile distilled with caustic soda gives benzoate of soda, from which hydrochloric acid precipitates benzoic acid. Attacked by nitric acid, the bichloride of naphthaline leads to an oil and forms binitrated chloride, or binitro-chloroform of Berthelot, of which the odour is so penetrating and the action on the eyes and respiratory organs so terribly deleterious. A few grms. are sufficient to cause the most painful burning to a thousand persons.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

December 22nd, 1870.

John Glover, Esq., President, in the Chair.

The minutes of the previous meeting were read and confirmed.

Messrs. Walter Bowman, Gateshead, and W. M. Sowerby, Jarrow, were unanimously elected as members. The names of Messrs. William Crowder and Henry Langdale were read for the first time.

The President read the following inaugural address:—

Gentlemen,—As I mentioned to you at our last meeting, the paper I am about to read was prepared for delivery on that occasion, but was not then read from causes which I explained. The honour you conferred on me by my selection as your President was quite unexpected on my part, and the notice of my election being of the shortest, I shall not attempt any formal address, but ask your indulgence while I point out some lines of thought and action which I think lie fairly before us as members of a chemical society. The first subject, both in absolute and relative importance, is that now stirring the public mind so deeply, viz., the application of the scientific knowledge of the age to the preservation of the public health generally, and its special application to the prevention of the serious mischief and waste consequent on our sewage arrangements. Many of you will be aware that this subject has been approached from almost every conceivable point, and yet, partly from its inherent difficulties, and perhaps still more from the financial difficulty and the force of habit, we appear to be as far from a true and practical solution of the problem as ever. If any of you can discover a process by which you can rapidly and cheaply remove from ordinary sewage all organic matter, whether soluble or insoluble, and all phosphatic salts, you will have almost solved the problem, and may expect to reap an abundant harvest both in honour and profit, besides securing the blessing of the "peacemaker," for surely he is entitled to that title who introduces harmonious action among natural laws where there was previous strife and consequent evil.

I will not detain you by describing any of the processes that have been tried to effect this end, for their name is legion, and I am not aware of one now in operation on a large scale which at the same time effects the end I have named and can be proved to be a financial success. Excepting the old plan of irrigation, all plans yet tried have been, practically, failures. The atmospheric conditions most conducive to a healthy life are pretty well known, and hitherto the evils arising from sewer emanations have been combated (when combated at all) by disinfectants, some based on their oxidising, and others on their deoxidising powers. The best disinfectant, other things being equal, is of course that which shall come into most intimate contact with the thing to be disinfected; therefore, for air pollution gaseous disinfectants must be absolutely essential, while for the disinfection of solids or liquids, disinfectants in a liquid form may be most effective. I mention this subject here to draw your attention to the mischief that may be done by the use of materials which are often puffed as being applicable to air disinfection, when their only possible use can be for the disinfection of solids or liquids, and even for this the use of some of them is questionable. In connection with this question it may fairly be asked why sewers should be allowed to poison the air with their gaseous emanations; surely the engineering skill of this country is equal to the task of so ventilating sewers that every opening shall draw air in, instead of allowing poisonous gases to issue from them. Newcastle, from the inclination of its sewers and cheapness of fuel, seems to be peculiarly well adapted for such ventilation.

As part of this question, the manufacture and purification of coal-gas have a peculiar claim on our consideration from circumstances to which I need not further allude; whether the balance is in favour of iron or lime purification is a subject we might profitably investigate, and also the relative merits of each in connection with the somewhat peculiar situation of our own gas-works. How far the existence of gas-works in large towns is compatible with health and comfort is a question which will require a combined medical, chemical, and mechanical knowledge; some other towns appear to have settled the question in the negative, as a few days ago I saw most extensive and expensive preparations making to remove a gas-work from a part of London where the population is very dense, to a distance of seven or eight miles down the Thames.

An examination of the water supplied to our town

would furnish a very excellent paper and one that would probably give rise to some valuable discussion.

If I mistake not, such chemical examinations would place our water supply in a more favourable position than many would suppose; you may gather my opinion from the fact that, after a chemical examination of many springs of water near my own residence, I have given the preference to the Newcastle company's water as a beverage. Beyond an occasional turbidity, which is easily removed, for drinking purposes, by a small filter, or even by subsidence, there is little to be complained of as a rule. This opinion I ask some of you to bring to the test of experiment, and as the experiments are not very difficult, I trust some of our members will make it the subject of a paper during the session.

I shall not risk wearying you by further dwelling on these subjects, as you may consider them too general in their nature, but I do ask you most earnestly to prepare papers on these, or similar subjects, as well as papers describing processes in which you find your daily work, *especially* describing any alteration or improvement in any known process, and, more important still, stating defects and needs in existing processes, so that discussion might be provoked, and thought be directed to useful ends. For instance, our medical members (of whom I am sorry we have so few) might give us some most interesting and useful papers on the germ theory of disease, and follow up the researches so ably carried on by Dr. Angus Smith and others. To some of you may, perhaps, fall the honour of proving whether or not zymotic diseases are propagated by living germs, and, it may be, proving that each disease has its specific germ, requiring a specific soil or condition for its germination or evolution.

The place of dialysis in the phenomena of life would also be a most interesting subject for investigation, or even the gathering up of all the information known on the subject would furnish a most interesting paper. The physics and chemistry of coal-mining would also be an interesting and useful channel for our thoughts and action, and one peculiarly appropriate to a Newcastle Society. The cause of the high temperature of coal-mines, whence is it? The opinion that it is due to mere depth is, I think, disproved by the fact that salt-mines, nearly as deep as the Monkwearmouth coal-mine are at a much lower, in fact, a comfortable working temperature; perhaps, investigations on the part of some of our members connected with the working of coal mines would show that the high temperature is caused mainly by a chemical action still going on in the coal itself. The important problem of producing a light which shall be safe under the varying conditions of coal-mining is yet unsolved, and any of you who can discover a practicable mode of generating light without heat, or with such a moderate degree of heat as would fail to ignite carburetted hydrogen, would solve the problem, and be hailed as one of the world's greatest benefactors. A safer mode of getting coals than by the use of gunpowder is much needed, and any substance you could discover for this purpose that should have a great and rapid expansive force, combined with a moderate elevation of temperature, say, below 1000° to 1200° of Fahrenheit, would bring both honour and profit to its discoverer, and confer an almost inestimable boon on the coal miner. The manufacture of pig-iron has been so very ably treated here and elsewhere by your ex-President (whose eminent fitnees for the work has been unanimously conceded), that it would be presumptuous in me to do more than allude to it, but he would be the first to tell you that there is room enough for all the ability and time you can devote to the consideration of that process. Especially in the matter of heating the blast is this true, while in the process of manufacturing pig into malleable iron and steel the Bessemer process has not exhausted improvement. The limited class of irons to which that process is applicable still leaves the field comparatively unoccupied. The enormous amount of fuel used in this process above that indicated by theory should engage the attention of such of you as have the combined chemical, mechanical, and physical knowledge, and the field is ample notwithstanding the many experimenters now occupying it. What is the essential difference between iron and steel, is it chemical or physical, or both? would furnish an interesting and useful paper from some of our members engaged in metallurgical chemistry, and would probably also give rise to considerable discussion.

The alkali manufacture may be said to still await the coming man. I will not say to introduce a shorter or more economical process than the present round-about process of Leblanc, as that would lead me into an examination and description of the almost numberless processes which have been proposed to effect that end, but rather to perfect that process. How far we are from having developed all the apparent possibilities of Leblanc's process may be judged by the results obtained in practice when brought to the test of its theoretic possibilities. Taking the best commercial sulphate of soda to contain 97 per cent of pure sulphate, all alkali manufacturers will agree with me that the amount of available soda obtained from such sulphate falls far short of that which theory indicates ought to be obtained. To make this clearer to you I have put in a tabular form what is actually got, and what we should have by theory.

100 of Commercial Sulphate at 97 per cent NaO,SO_3 contains 42·3 Soda (NaO=31).

Soda-Ash at 52 per cent soda.			Ash at 54 per cent.	
To obtain of soda-ash from 100 of sulphate.	Shows loss of soda (NaO).	Equivalent in soda-ash.	Loss of soda.	Equivalent in soda-ash.
70	5·9	11·3	4·5	8·3
71	5·4	10·4	4·0	7·4
72	4·9	9·4	3·5	6·5

From this table you will observe that, taking the best commercial sulphate to contain 97 per cent of sulphate of soda, we should obtain from it 42·3 of soda (NaO=31). Now, in practice, different manufacturers obtain varying results, but they will be about covered by the figures in the table. Thus, some manufacturers obtain a soda-ash containing 52 per cent of soda, and a yield of 70 per cent from the sulphate used; in this case they are short of the theoretic amount they should obtain from 100 of sulphate, 5.9 of available soda, or 11·3 of such ash. If 71 per cent of a 52 per cent ash is obtained from the sulphate used, then are they minus 5·4 of available soda or 10·4 of such ash, and at 72 per cent from sulphate (which is a quantity scarcely if ever exceeded) they are minus 4·9 of available soda or 9·4 of ash. To pass to the next division of the table—taking the work of a manufacturer who is making a soda-ash containing 54 per cent of soda, we still find there is ample room for improvement; thus, taking his yield of ash from sulphate at 70 per cent (which is, I believe, common at this strength) he is (for each 100 of sulphate used) minus 4·5 of available soda or 8·3 of such ash; at 71 per cent yield of ash he is minus 4·0 of available soda or 7·4 of such ash; and at 72 per cent of ash from sulphate he is still minus 3·5 of available soda, or 6·5 of ash, containing 54 per cent of soda. Now, we know that a considerable portion of this loss of soda occurs in the furnaces and lixiviating tanks, but how it occurs there, or in what form some portion of it exists in the tank waste, has not been satisfactorily shown. To prevent misunderstanding here, allow me to observe, what many of you are, I have no doubt, aware of, that the largest portion of this loss of available soda is due to the imperfect decomposition of sulphate of soda in the ball furnace, and also (but, I believe, in a much less degree) to imperfect lixiviation of the balls. Probably as much as 4 of soda in the 52 per cent ash, and 2 of soda in the 54 per cent ash, is due to these causes. And here I would urge upon such of our members as have time and opportunity to institute some experiments of research in this direction, and let us have the scientific result of their labours.

To those of you who are more directly engaged in

analytical chemistry I would suggest the institution of researches, having for their object to explain, and so go far to prevent, the varying results we get in the examination and valuation of the material used and made in our various manufactories; all of you who are actively engaged in manufactures will know the great annoyance we have from this source.

As my warrant for the observations I have just made, I beg to draw your attention to this tabulated result of the examination of seven different samples of sulphur ore (pyrites) by three different chemists, each having the same sample to operate on.

No.	Sulphur, per cent.			Difference between A and B.	Difference between A and C.
	A	B	C		
1	38·8	38·0	40·2	0·8	1·4
2	40·9	40·9	42·7	—	1·8
3	39·6	39·1	41·1	0·5	1·5
4	39·3	39·5	40·7	0·2	1·4
5	41·6	41·4	43·5	0·2	1·9
6	38·2	38·0	40·0	0·2	1·8
7	39·7	39·2	41·1	0·5	1·4
		Average	.. ..	0·34	1·6

You will observe that between A and B there is comparatively little difference, the maximum amount being 0·8, while between A and C the maximum difference is 1·9; the average difference between A and B is only 0·34, but the average difference between A and C is 1·6.

I ought to mention that A and B are local chemists, but residing and working in different parts of the district, and acting quite independently of each other, and that C is a metropolitan chemist; also that A and C are professional analytical chemists; B is chemist in the laboratory of the purchasers of the ores. I need not pursue this branch of the subject further, although many of you are aware that my observations would apply with even greater force to manganese and other materials used in the manufactures of the district. If I had time, and the requisite knowledge, I might go through all the manufacturing operations of the district, and point out in each the need and opportunity for useful work. I trust these observations will induce you to give what aid you can in the development of our infant society, so that it may take a place among the scientific societies of our land worthy of the manufacturing district in which we are placed. In justice to myself, a few words more, and I have done. Some of you may have imagined that most of my recommendations have a mere money value for their end, and have not been made in the interests of pure science. If this it so, it is not, I assure you, because I undervalue the pursuit of science for its own sake; for, I believe, that such of you as devote yourselves to purely scientific investigations, from the promptings of a pure and devoted love, may not, as your reward, gain material wealth, but you will have formed, what is of infinitely greater value, a noble character, and a *capacity* for enjoyment which mere wealth cannot give.

Mr. I. L. BELL.—Mr. President and Gentlemen,—I am sure you will at once divine the object which I have in rising to address a few words to this meeting; it is to tender our very hearty thanks to the President for the very admirable and painstaking address which he has just delivered. I trust the advice which he has tendered to the members of this society, and I will say more particularly to the younger members of the society, will be taken note of, and that we shall at no distant period be able to say that we have reaped some advantage from the address which he has placed before us in so pointed, and indeed I may say in such eloquent, terms. No doubt the address itself has partaken, as our President has justly stated, in a great degree of the utilitarian phase; but I ventured, in an address which I had the honour of delivering before this body, to state that it could scarcely be expected of gentlemen engaged, not in the pursuit of abstract science, but rather in the application of science to the general purposes of life, that any great or important contribution could be afforded by us to abstract science. But notwithstanding, it cannot be denied that of all classes of the community there is none so capable of affording knowledge of a particular kind as we ourselves, engaged as we are in the application of those great scientific truths which have been taught to us by the chemists of the day—engaged as we are, as I have stated, in the application of those truths to practical purposes. Possibly, indeed certainly, there can be no application of science of a more interesting character than that where it seeks to elevate the standard of public health; and I am glad indeed that our President has drawn your attention to this subject. I will only state in reference to this, and in justice to a body with which I have the honour of acting, namely the Town Council of Newcastle, that to a certain extent the recommendations of the President have been forestalled by that body, because we have, I am glad to say, an accomplished chemist (Mr. Pattinson), a member of the Newcastle Chemical Society, from whom we receive periodically reports on the quality of the water supply to the town as well as on the quality of the gas; and I take this to be a very important function, indeed, of every municipal corporation, that in a matter affecting, so directly as it does, the public health, every pains should be taken to assure to those who consume the water an article of the highest possible purity. In conclusion, I would ask the meeting to do that which I have no doubt they will be too happy to acquiesce in, namely, to record a vote of very hearty thanks to the President for the very able address with which he has just favoured us.

The proposition was carried by acclamation.

The PRESIDENT—I have to thank you, gentlemen, for the very hearty manner in which you have responded to Mr. Bell's proposition. It will always give me the greatest pleasure to contribute what I can to the prosperity of this society; and, with Mr. Bell, I do hope that the younger members of this society will not be diffident in preparing papers to submit to the society. We want some young and fresh thought; and although the ideas may sometimes be crude, yet they may give rise to very useful discussions, discussions which may in the end prove of value where the papers themselves might, perhaps, not be of value. I thank you heartily, gentlemen.

ROYAL IRISH ACADEMY.

A GENERAL meeting of the Academy was held on Monday, the 23rd. Professor HENNESSY in the chair.

Professor ROBERT S. BALL, read a report, which was illustrated by diagrams and experiments, "*On the Resistance of the Air to the Motion of Atmospheric Vortex Rings.*"

This was one of the reports for which the Academy had voted a grant of money.

If it were not for the friction of the air these vortex rings would move on for ever, but the resistance of the air finally stops and disperses them. These vortex rings made apparent by smoke or steam are sometimes well seen proceeding from the orifice of a railway engine.

The result of Professor Ball's experiments, which had been very numerous, was the determination of a law—which law may be stated as follows:—The resistance of the air is directly proportional to the first power of the velocity.

There were three more papers read, but the only scientific one was by Dr. Macalister, "*On Observations on Muscular Anomalies in Human Anatomy.*"

NOTICES OF BOOKS.

A Laboratory Text-Book of Practical Chemistry; or Introduction to Qualitative Analysis. By William G. Valentin, F.C.S. Published by Churchill. Price 10s. 6d.

Conscious, no doubt, of the great dearth of text-books, Mr. Valentin has, under the title quoted above, given to the world what must be regarded as the official primer, so to speak, of the only school of chemistry which is acknowledged by government.

For years the painstaking and successful instructor in the laboratory of the Royal College of Chemistry, and a thoroughly practical and experienced analyst, our author is highly qualified to deal with the requirements of the student. He has also the advantage of acting under the superintendence of Dr. Frankland, so that both theory and practice are ably represented in the work before us.

Beginning with the preparation of gases, Mr. Valentin, with excellent practical examples at every step of the way, takes the student through the theory of modern chemistry, combining proportions, atomic theory, molecular volumes, &c.; the last chapter of this portion of the book giving, curiously enough, a definition of the science. In the second part, the subject of qualitative analysis is taken up. The metals, separated into groups, are illustrated by an elaborate and varied series of reactions, each of which is fully explained to the student, with the chemical formula for each step. Coming from the school of Frankland, the "graphic" mode of indicating the composition of substances is, of course, religiously given; indeed, occasionally, from the omission of the usual summary of the constituents, a person accustomed to the well-known manner of writing well-known compounds does not recognise his old acquaintances till he has added up his atoms in much the same manner as a column in an account book. This is, however, not likely to incommode a student going regularly through the course. After each division of the subject, a series of capitally chosen questions is given, leading the student to the application of what he has previously learnt, to the calculation of most chemical problems, and to the formation for himself of schemes for separation of metals not given in the text—a series of mental gymnastics not unduly disproportioned to his strength, but admirably adapted to his attaining a sound mastery of his subject. About sixty pages at the end of the volume are devoted to very full analytical tables, including the identification of many organic acids, more than commonly enter into such tables.

It is somewhat singular that, with great profuseness of illustrative reactions, the precautionary measures occurring at every step are somewhat meagrely dealt with, except in so far as a reader of previous experience may notice them incidentally in the body of the work. No summaries of special methods whatever are given.

And one very great deficiency is felt in the scheme of analysis given in this the text-book, as we have said, of the only chemical school the British Government has ever deigned to assist and countenance, namely, that about one-third of the elements are *ignored*, except as to placing them in a list.

This saves, it is true, an infinity of trouble, and, since all the commoner substances are fully handled, for trade purposes he is not likely to require more. But, if ambitious to become a philosophic cultivator of science, and an investigator, he will have, after mastering a scheme of analysis, subsequently to modify and add to that method. Besides which, sundry elements, commonly called rare, are met with much more frequently in mineral examinations than when they were more seldom looked for, as, for instance, lithium, titanium, &c.; yet, during the last twelve years, the translation of "Fresenius," and the tables in Dr. Noad's work, and Connington's translation of Will's book, are the only attempts, so far as we are aware, in our language at comprehensive analysis. It is, surely, beneath the dignity of a laboratory, aspiring to be considered national, that its manual should take such a low and unphilosophical position as to neglect completeness, and miss the opportunity of dealing with imperfectly occupied ground. But, although the scantiness of the course, and its omissions, as it at present stands, would be fatal to the acceptance of this work as a standard treatise on practical analysis, yet these are faults which might, and we would fain hope will, be removed by an appendix to the present edition and an incorporation with a future one. And, as regards a practical foundation of thorough knowledge of chemical reaction and of "learning the elements" as it is popularly termed, Mr. Valentin's book will take a remarkable position, and one thoroughly well deserved, from the great thought and pains evident throughout it, to advance the student quickly, soundly, and comprehensively.

The Retrospect of Medicine: being a half-yearly journal containing a retrospective view of every discovery and practical improvement in the medical sciences. Edited by W. Braithwaite, M.D., &c., and by James Braithwaite, M.D. Lond. Vol. lxii., July—December, 1870. London: Simpkin, Marshall, and Co. 1871.

This well-known bi-annual periodical deserves, as usual, the attention of medical practitioners. It is evident, at a glance, that the authors are exceedingly well up to the arduous task of compiling a volume, as this is made to contain, compressed and condensed into some 400 pages, an enormous amount of very judiciously and carefully written matter relating to that extensive field of sciences included in the general term of "Medicine." For the chemist we quote the following new test for albumen:—Add to the liquid to be examined, in a test-tube, 10 minims of alcohol of 0·805 sp. gr., shake thoroughly, but gently, so as to avoid the production of froth; then add, by drops, the same quantity of carbolic acid, and shake very thoroughly; allow the tube to stand for a minute and, if the merest trace of albumen is present, distinct flocculi will be seen floating in the liquid. This test is much more delicate than the heat and nitric acid test. Although, as might be expected, Dr. C. M. Tidy applies this test especially for the detection of albumen in urine, it (the test) may, perhaps, be applicable to detect albumen, when present in small quantity, in other fluids. Of the work before us we may say that, in order to render reference an easy matter, the authors have added, in addition to a table of contents and copious index, a very carefully made synopsis, which greatly enhances the value of the volume.

CORRESPONDENCE.

ANTISEPTICS AND DISINFECTANTS.

To the Editor of the Chemical News.

Sir,—When Dr. Calvert was experimenting upon disinfectants, I am surprised that he did not include amongst his experiments the powder known as "Mudie's Disinfectant." I think he would have found that the antiseptic powers of that body would have been equal to the carbolic acid powder; as "Mudie's Disinfectant" contains so large a percentage of anhydrous sulphate of iron mixed with a certain proportion of alum and red sulphate of iron, it plays the treble parts of deodoriser, disinfectant, and antiseptic.

With regard to the much vaunted "Chloralum" I see Professor Gamgee says in his letter of January 13th, "The agent (chloralum) had never been thought of in therapeutics until last January;" again, in his letter of the 27th, "since I first thought of the chloride as an antiseptic just a year ago." In Ure's "Dictionary," 1863, Article "Disinfectants,"

chloride of aluminium is mentioned as an antiseptic; it says, "Meat, if well packed, cleaned, and washed with a solution of chloride of aluminium, will keep three months." After that I hardly think Professor Gamgee can lay claim to the discovery of the antiseptic and therapeutic properties of chloride of aluminium.

He also says that chloralum covers a larger field of useful applications than carbolic acid; surely there must be some slight mistake here, for chloralum is not able to remove the smell from alkaline sulphides, as any one can prove by a simple experiment. I sent for a bottle of chloralum, and compared it with Mudie's disinfectant. Not having a badly smelling midden or cesspool close by, I used some yellow sulphide of ammonium to test the deodorising powers of the two compounds. With Mudie's the smell immediately disappeared; instead of chloralum removing the odour, it made it rather worse, as sulphuretted hydrogen was liberated in abundance, thus showing that it is not able to remove so noxious a gas. Sulphide of ammonium being generated in middens and cesspools, I cannot think that chloralum is a good deodoriser for water-closets and such like places.—I am, &c.,

J. CARTER BELL.

Manchester.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Annalen der Physik und Chemie, von Poggendorff (Supplementary number), vol. v., No. 2, 1870.

This number contains the following original papers and essays:—

Researches on the Specific Heat of Mixed Fluids.—J. H. Schüller.—This paper is the concluding portion of an algebraico-physical essay containing the following chapters:—Alcohol and chloroform; alcohol and benzol; chloroform and sulphide of carbon; sulphide of carbon and benzol; chloroform and benzol. The general result of the author's researches is, that in the case of mixed liquids, as those referred to, the true specific heat can be either greater than the mean specific heat of each liquid by itself, or it can be the same; but these researches do not show whether, when each of these instances occur, there may not also occur what is frequently observed with saline solutions, viz., that the specific heat observed is less than the mean. The author concludes by stating that he is engaged with another series of experiments to elucidate this matter.

Maximum of Density and Expansion of Distilled Water, of the Water from the Adriatic Sea, and of some Saline Solutions.—Dr. F. Rossetti.—This monograph contains the account of a series of experiments on the subjects above-named. The paper is not suited for any useful abstraction, on account of the large number of tabulated forms exhibiting the results of experiments.

Subjective Phenomena of Colours.—J. K. Becker.—This paper contains a lengthy discussion on a statement made by Dr. Helmholtz in reference to physiological optics, which statement the author thinks is erroneous; and he tries to explain certain phenomena of vision on purely physical grounds.

Passivity of Iron; and on Electrolysis.—L. Schönn.—The author states, that when a piece of iron is tightly fastened to a piece of charcoal, care being taken to make the contact betwen the charcoal and well-polished iron as perfect as possible, and also to immerse both these substances simultaneously into the nitric acid, the iron is not dissolved; but, as soon as either the metal or the charcoal are touched, under the surface of the acid, with a strongly electro-positive metal (for instance, zinc), the iron becomes at once active again, and is dissolved in the acid with a copious evolution of gas. When some very dilute hydrochloric acid, so weak that it hardly acts upon zinc, is poured into a platinum basin, and a piece of zinc placed in that liquid in metallic contact with the platinum, a copious evolution of hydrogen takes place at once, precisely on the spot where the zinc, platinum, and acid are in contact. If, instead of the very weak acid, an aqueous solution of corrosive sublimate is taken, and the experiment repeated, metallic mercury is separated at the point of contact between the zinc, platinum, and the solution. The author finally states that, from a series of experiments made by him, he has found that all desired electro-chemical actions can be called forth at pleasure by simply placing either two different metals, or charcoal and metals, in contact with a fluid.

The American Journal of Science and Arts, January, 1871.

This number contains the following original papers and essays relating to chemistry and allied sciences:—

Quaternary, or Post-Tertiary, of the Newhaven (Connecticut, U.S.), Region.—J. D. Dana.—The first portion of a memoir which, although bearing more especially on the locality above named, contains matters of general interest to geologists.

Corona Seen in the Total Eclipses of the Sun.—Professor W. A. Norton.—Reserved for reproduction in full.

Duration of Flashes of Lightning.—O. N. Rood.—The result of the author's experiments on this subject is that the duration of flashes of lightning, as observed by him, and measured by means fully described in this memoir, during a violent thunderstorm in August last, amounts, in round numbers, to about 1-500th of second, the average length of the streak being 9°.

Physical Condition of a Closed Circuit Contiguous to a Permanent and Constant Voltaic Current; or, on "the Electrotonic State."—Dr. A. M. Mayer.—Illustrated by diagrams.

Gahnite from Mine Hill, Franklin Furnace, New Jersey, U.S.—G. J. Brush.—The author describes the mineralogical characters of this rare species of mineral found in a zinc mine. The mineral is crystalline; colour, blackish green; hardness, 7·5; sp. gr., 4·89 to 4·91; infusible before blowpipe; with fluxes, reacts for iron and manganese, and with soda on charcoal gives a zinc coating. The composition of this mineral, in 100 parts, is—Alumina, 49·78; ferric oxide, 8·58; zinc oxide, 39·62; manganous oxide, 1·13; magnesia, 0·13; silica, 0·57. This variety of gahnite (so named after the celebrated Swedish mineralogist, Gahn) shows a larger percentage of zinc than any specimen of this mineral heretofore analysed; it is associated with black mica, apatite, calcite, and a brownish variety of chrysolite, which, on partial analysis, was proved to be a mono-silicate of iron, manganese, and zinc.

Meteors of November 13th and 14th, 1870.—H. A. Newton.

Some Phenomena of Binocular Vision.—J. Leconte.—The fourth part of a lengthy memoir on this subject, largely illustrated with wood engravings.

Earthquake of October 20th in North-Eastern America.—A. C. Twining.—A very full and careful account of this phenomenon as observed and felt in the country alluded to. Among the surprising results detailed in this paper, we find that the earthquake wave progressed from about E. 6° N. to about W. 6° S. at the rate of 160 miles a minute, being six minutes and a half from St. John's, New Brunswick, to Chicago, Illinois, a distance of nearly 1200 miles in a straight line. The ordinary direction of the subordinate undulation was about N. by E.

American Journal of Pharmacy, No. 1, 1871.

This number contains the following original papers more particularly relating to chemistry and physical sciences:—

Carré's Apparatus for Making Ice.—W. Procter, jun.—The invention of M. Carré consists in the use of ammoniacal gas, liquefied by pressure, as the agent for freezing water, which it does by abstracting and rendering latent the heat necessary to the liquid condition of water. The manner of using the aqua ammoniæ (concentrated liquid ammonia) to effect this purpose is exceedingly ingenious, and apparently paradoxical, inasmuch as "heat is applied to produce cold;" "fire to make ice," this being one of the claims of originality made by the patentee; the other claim being "the application of the power of absorption due to mutual affinity as a means of producing vacuum, volatilisation, the removal of heat, and the consequent production of cold." The greater part of this paper is devoted to the description of the apparatus used for the manufacture of ice, the machinery being illustrated by engravings.

Sulpho-Carbolic Acid and Sulpho-Carbolates.—J. Creuse.—After briefly referring to the more extended use of the substances just named in medicine and pharmacy, the author says that his intention is to prove that—(1) sulpho-carbolic acid is composed of 3 equivalents of sulphuric and 1 equiv. of carbolic acid; (2) that to combine carbolic and sulphuric acids without waste of carbolic acid, it is necessary to take 6 equivs. of the latter and 1 of the former; (3) that sulpho-carbolates are composed of 2 equivs. of the acids and 3 of the base. The process of examination employed by the author consists in heating together various proportions of the two acids, and, by means of carbonate of baryta, determining what quantity of sulphuric acid is converted into sulpho-carbolic acid, what proportion of it remains free, and how much carbonate of baryta is transformed into the sulpho-carbolate of the base. The mode of preparation of sulpho-carbolic acid, to be used medicinally, is described at length. The pure sulpho-carbolic acid is colourless, has no smell, dissolves in dilute alcohol and ether in all proportions; the acid has no antiseptic properties, because its aqueous solution becomes mouldy in forty-eight hours during hot weather; nitric acid, especially if aided by heat, decomposes it, forming, among other compounds, picric and sulphuric acids. The sulpho-carbolate of soda may be prepared by saturating sulpho-carbolic acid with carbonate of soda; the ensuing sulpho-carbolate is colourless, but reddened by direct exposure to sunlight. The shape of the crystals is like sulphate of zinc; the soda-salt neither effloresces nor deliquesces; it tastes like sulphate of soda, slightly bitter and saline, but not acrid; nitrate of baryta does not precipitate the soda-salt. The

sulpho-carbolate of zinc crystallises in the shape of flattened prisms; is colourless; soluble in water and alcohol; not precipitated by salts of baryta; is far more readily affected and coloured by direct sunlight than the soda salt, and, like it, cannot be kept in weak solutions during hot weather without becoming mouldy.

Cheap Process for Preparing Artificially-Precipitated Carbonate of Baryta.—J. Creuse.—After referring to the great value of artificially-precipitated carbonate of baryta to chemists, and the imperfections of the modes of obtaining it, the author suggests the following method of preparing the substance alluded to:—Take of witherite (native carbonate of baryta), in small lumps or in powder, a convenient quantity, add to it from four to five times its weight of water, and dissolve it with hydrochloric acid gradually; keep rather an excess of baryta than of acid, allow to settle, and decant the clear liquid. To this add a solution of oxalic acid as long as a precipitate is formed, and, though a slight excess is not objectionable, 30 grains are generally sufficient for each pound of witherite (the proportion may vary, however, according to the purity of that mineral). Let the liquid stand for one hour, filter, and add to the filtrate a quantity of caustic soda just sufficient to give it a decided alkaline reaction. After an hour's rest filter again, and treat the liquid by a solution of carbonate of soda; collect and wash the precipitate in the usual manner. This process of purifying is based on the fact, observed by him, that when a solution of oxalic acid is added to a liquid containing salts of lime and baryta both, all the lime is precipitated first, and immediately; after the lime is eliminated, caustic soda precipitates all the foreign bodies likely to be present, such as iron, alumina, &c. It may be objected that this process does not remove strontia; but, in the first place, strontia seldom occurs in witherite, and the old process for making baryta salts from the sulphate also leaves strontia if it is present; while, if the precipitated carbonate be required absolutely pure, it is only required to modify slightly the above-described *modus operandi*, and use pure chemicals.

Resignation of W. Procter, jun., as Editor of this Periodical.—From the Minutes of the College of Pharmacy we learn that, after having held the post of editor of this work for a period of twenty-five years, Mr. Procter has tendered his resignation. His resignation was received with sincere regret on the part of the Philadelphia College of Pharmacy, which institution loses a most able editor and very widely-known exponent of pharmaceutical, as well as, we may add, general sciences. The regret felt in America is shared by us, for we have long known and esteemed the eminent editor who has so ably filled this responsible post.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 18, 1870.

This number contains the following original papers and essays:—

Constitution of the Native Combinations of Tantalum and Niobium.—Dr. C. Rammelsberg.—This paper treats on hjelmite, a mineral met with near Kararshof, Sweden. The mineral is infusible in the blowpipe-flame; black-coloured; sp. gr., 5·655. In 100 parts this substance contains—Ta_2O_5, 54·52; Nb_2O_5, 16·35; SnO_2, 4·60; WO_3, 0·28; UO, 4·51; MnO, 5·68; FeO, 2·41; CaO, 4·05; YO, 1·81; CeO, 0·48; MgO, 0·45; H_2O, 4·57. The author quotes in full the results of the analysis and of other researches made on this substance by Dr. Nordenskiold. The chief difference between these analyses is, that the author of this paper found more (6·5 per cent) tantalic acid, and less Fe and Y.

Some of the Properties wherein Hydrogen and Oxygen Agree.—J. Thomsen.—From this paper we can only quote some of the main points which the author has deduced from the results of his experiments. One litre of dry hydrogen at 0° and 760 m.m. at latitude 45° and sea level yields, on combustion, 0·8041 grm. of water; at the same latitude, and under the same normal conditions, 1 litre of oxygen weighs 1·4293 grms., and two litres of hydrogen weigh 0·1791 grm., together a weight of 1·6084 grms. The author found that the combustion of 2 litres of hydrogen yield 1·6082 grms. of water, whence it follows that 2 volumes of hydrogen combine exactly with 1 volume of oxygen to form water. From this fact the author concludes that, since $\frac{1·4293}{0·08954} = 15·963$, the atomistic number of oxygen is equal to 15·963.

The quantity of heat developed by the combustion of 1 grm. (absolute weight) of hydrogen to water is equal to 3782 caloric units (calculated for vacuum); the calorific factor of hydrogen may therefore be taken at 34,000, a number which differs about 1 per cent from the figures generally adopted.

Some Lecture Experiments.—J. Thomsen.—The first of these experiments is described under the title of the *Reciprocal Combustion of the Elements of Water.*—In order to illustrate the arrangement of the required apparatus, a woodcut has been added, which is required for the proper understanding of the mode of displaying the phenomenon of first burning hydrogen in an atmosphere of oxygen, and next the last-named gas, in an atmosphere of hydrogen. *Combustion of Oxygen with a Sooty Flame.*—Take a long-necked flask; pour into it some benzol or oil of turpentine; close the flask with a doubly-perforated cork through which two short glass tubes are passed, one of which should be of about 1 centimetre internal diameter, the other is narrower and somewhat bent sidewards. Let the liquid in the flask be boiled, and, as soon as the vapours issue from the wider tube, ignite them; and, this having been done, there is passed through that tube another narrower glass tube connected with a suitable gas-holder, or other vessel, containing oxygen. This tube should be provided with a platinum burner bent upwards and fitted with a cork, which closes the opening of the wider tube. This oxygen-carrying tube is made to pass deep into the flask; and immediately after the closing of the 1 centimetre wide tube, the oxygen begins to burn with a sooty flame, while the excess of the vapours of the boiling liquid are discharged by the narrower glass tube above alluded to. *Oxidation and Reduction, and the Change of Weight accompanying this Phenomenon.*—Take oxide of copper; make it, by means of weak gum water, into a paste, and shape that into a cylindrical form 1 centim. in diameter by 3 centims. in height; dry it; ignite it gently; next reduce it, by means of hydrogen, to the metallic state at as low a temperature as possible; cool in the current of the gas just named; and next wind round the cylinder a platinum wire, the free end of which should be molten into a glass rod, so as to be used as a handle. This having been done, have ready two tubulated bell-jars—one turned with its wide opening downwards, to hold hydrogen gas, to be carried into it by a flexible tube through the tubulus; the other jar, with its wide opening turned upwards, to hold oxygen. Now heat the copper cylinder (which, although very porous and spongy, has sufficient cohesion to be submitted to the experiments) gently, taking care not to make it red-hot, and immerse it into the oxygen, whereupon it will become suddenly red-hot, and continues so until the oxidation is finished. After having sufficiently cooled, the cylinder is transferred to the jar containing hydrogen, when again it begins to ignite, throwing off a strong light, while water condenses on the sides of the jar. Since the change of weight by the alternate process of oxidation and deoxidation, of a cylinder of the above dimensions is nearly 1 grm., it may be exhibited in a lecture-room by an ordinarily good balance.

NOTES AND QUERIES.

Protochloride of Antimony.—Will any of your readers favour me with the process of making protochloride of antimony, or inform me where I can get it ready prepared?—Amateur Chemist.

Coating Cisterns.—Could any of your correspondents inform me if silicate of potash, or any other similar material could be advantageously used to coat brick and cement cisterns in order to make them perfectly water-tight?—R. Binns.

Soldering Iron and Steel.—Can you inform me, through your valuable paper, of a solution suitable for soft-soldering iron and steel, and which, if left on, will not rust it? Such a solution is used by some, but I cannot tell how it is made or where to buy it. Chloride of zinc is said to answer, but in my experience it rusts the work if left on it. George G.

MEETINGS FOR THE WEEK.

Monday, Feb. 6th.—Medical, 8.
—— Royal Institution, 2. General Monthly Meeting.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology. (Educational Course.)
Tuesday, 7th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
—— Zoological, 9.
—— Ethnological, 8.
Wednesday, 8th.—Society of Arts, 8.
—— Geological, 8.
—— Microscopical, 8. Anniversary.
Thursday, 9th.—London Institution, 7.30. Mr. F. S. Barff, M.A., F.C.S., "On the Action, Nature, and Detection of Poisons."
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Royal, 8.30.
—— Royal Society Club, 6.
Friday, 10th.—Royal Institution, 9. E. J. Reed, Esq., C.B., "On some Fallacies connected with Ships and Guns."
Saturday, 11th.—Royal Institution, 3. Rev. W. H. Channing, "On Laws of Life Revealed in History."

TO CORRESPONDENTS.

*** Vol. XXII. of The Chemical News, containing a copious index is now ready, price 11s. 8d., by post, 12s. 2d., handsomely bound in cloth, gold-lettered. The cases for binding may be obtained at our office, price 1s. 6d. Subscribers may have their copies bound for 2s. 6d. if sent to our office, or, if accompanied by a cloth case, for 1s. Subscribers wishing to complete their sets of volumes are requested to apply to the publisher, who will give them information respecting scarce numbers and volumes. Vol. xxiii. commenced on January 6th, and will be complete in twenty-six numbers. Reading Cases, price 1s. 6d. each post free, may also be obtained at the Office.

George Cathcart.—We believe there is no such process.

E.C.C. Stanford.—Your communication arrived too late for insertion in the present number.

J. R.—We shall probably give the process in an early number.

BOOKS RECEIVED.

On a Localised Outbreak of Typhoid Fever in Islington during the Months of July and August, 1870. By Edward Ballard, M.D. London: J. and A. Churchill.

Sixth Annual Catalogue of the Officers and Students, and Programme of the Course of Instruction, of the Massachusetts Institute of Technology.

THE CHEMICAL NEWS.

VOL. XXIII. No. 585.

ON THE

DETERMINATION OF SULPHUR IN CAST-IRON.

By ARTHUR H. ELLIOTT.

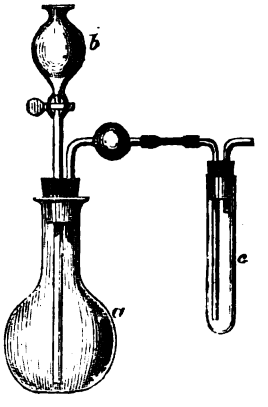
MOST of the methods at present in use for determining the sulphur in cast-iron are worked so as ultimately to obtain the sulphur as sulphuric acid, and precipitate the latter as sulphate of barium. In some methods, this end is attained by treating the iron with acid, eliminating the sulphur as sulphuretted hydrogen, catching the latter in an alkaline solution of lead or zinc, and, after collecting the metallic sulphide formed, oxidising it by fusion or treatment with acids. In other methods, the sulphur is oxidised direct in the iron, without previous separation from the latter. There are many objections to these methods. In the first, the operation of fusing is well known to be a troublesome experiment; and, to add to the number of preliminary operations, the oxide of the metal soluble in alkalies, left in the solution of the fusion of the metallic sulphide, has to be separated previous to precipitating with chloride of barium. In the second case, of oxidising direct by treatment with acids, a tedious evaporation is incurred to separate silicic acid before precipitating with chloride of barium. Again, when a number of analyses have to be performed, the precipitating with chloride of barium becomes an operation it would be well to dispense with if possible.

To meet these objections, and place in the hands of chemists a ready, and, at the same time, accurate, method for the determination of sulphur in iron, I have devised and used the following process, which I find is expeditious and gives concordant results. It depends on the evolution of the sulphur as sulphuretted hydrogen, the absorption of the latter in solution of soda, and determination of sulphuretted hydrogen in the acidified soda solution with standard solution of iodine.

Preparation of the Standard Iodine Solution.—Dissolve about 5 grms. of iodine, with about 7 grms. of iodide of potassium, in 1000 c.c. of water. Now prepare a solution of hyposulphite of sodium containing about 25 grms. of the salt in 1000 c.c.; this is used to standardise the iodine by means of standard solution of bichromate of potassium. The standard bichromate is made by dissolving 4·92 grms. of the pure fused salt in 1000 c.c.; 1 c.c. of this solution is equal to 0·0127 of iodine. To find the value of the iodine solution, proceed thus: Take 20 c.c. of bichromate solution, add 10 c.c. of solution of iodide of potassium (1 in 10), and about 15 c.c. of hydrochloric acid (1 part of strong acid to 2 parts water). Now add from a burette the hyposulphite solution, till the solution in the beaker is greenish yellow; add to this a little clear starch-paste, and continue adding the hyposulphite till the blue colour produced disappears, leaving a clear green solution. You will now have the value of the hyposulphite in terms of iodine. From this, standardise the iodine solution, by taking 20 c.c. and adding the hyposulphite till one drop makes the solution colourless. The calculations are made as follows:—Suppose 20 c.c. of bichromate are equal to 21·8 c.c. of hyposulphite, and 20 c.c. of iodine are equal to 7·6 c.c. of hyposulphite. Then, as 20 c.c. of bichromate are equal to 0·254 of iodine, 21·8 c.c. of hyposulphite are equal to 0·254 of iodine; therefore 1 c.c. of hyposulphite is equal to 0·01165 of iodine. As 7·6 c.c. of hyposulphite are equal to 20 c.c. of iodine solution, 20 c.c. of the iodine solution are equal to 0·08854 of iodine; therefore 1 c.c. is equal to 0·004427 of iodine. But, according to the following reaction, $H_2S+I_2=2HI+S$, I_2 is equal to S, or, 254 of iodine are equal to 32 of sulphur. Therefore, by further calculation, 1 c.c. of iodine solution is equal to 0·000557 of sulphur.

The Process.—The apparatus is used for dissolving the iron and catching the sulphuretted hydrogen formed. The narrow-necked flask, *a*, holds about 500 c.c.; the funnel-tube, *b*, has a bulb holding about 70 c.c., and is provided with a glass tap. The exit-tube from the flask has its end ground obliquely, to allow the liquid condensing in it to drop back into the flask without stopping the passage; it is also provided with a bulb to catch the condensed liquid, and prevent it passing into the absorption-tube. The tube, *c*, is about 10 centimetres long, and 18 m.m. wide; it is provided with tubes, one passing to the bottom, the other an exit-tube. This tube is of thick glass, and is one of those usually sold to keep specimens. It is half filled with solution of soda, made by dissolving 1 part of the soda made from sodium in 5 parts of water; this solution does not use up any iodine after being acidified and mixed with starch paste. A second tube, containing a strong solution of iodine in iodide of potassium, may be connected with the tube containing the soda, to absorb the phosphoretted hydrogen, which has a very disagreeable effect upon the operator.

Five grms. of the finely-powdered drillings of iron are taken, and transferred to the flask by means of a piece of



glazed paper. The paper containing the iron is coiled up so as to form a cylinder; it is then placed in the neck of the flask whilst the latter is held horizontally; the flask is then turned up vertically, and the iron allowed to fall in, retaining the paper with the finger; the last particles are removed from the paper by tapping the neck of the flask. After adjusting the cork containing the funnel-tube, and attaching the absorption-tube, 70 c.c. of dilute hydrochloric acid (1 part of strong acid to 2 parts of water), are poured into the bulb of the former, the glass tap being closed. A little acid is now allowed to enter the flask, and the contents of the latter are thoroughly mixed by shaking. When the action has abated, more acid is allowed to enter, the contents of the flask being mixed by shaking at each addition. When the iron is thoroughly decomposed, place a gentle flame under the flask, regulating the heat by the rate of bubbling through the absorption-tube. When the contents of the flask boil, keep boiling for some minutes, until they threaten to boil over. Now remove the lamp from under the flask, and, simultaneously, open the glass tap of the funnel-tube. Care should be taken that the tap works easily before beginning the experiment. Remove the absorption-tube from the rest of the apparatus, wash the contents into a beaker holding about 500 c.c., dilute with about 200 c.c. of boiled water,* acidify with hydrochloric acid, add a little clear starch

* The reaction between the sulphuretted hydrogen and iodine cannot be depended on if the solution contains more than 0·04 per cent of sulphuretted hydrogen.—BUNSEN.

paste, and titrate with the standard solution of iodine till blue.

Phosphoretted hydrogen, which is also formed on treating the iron with acid, is not absorbed by solution of soda. I proved this before proceeding to work with the above process.

The following determinations were made by this method on two samples of iron :—

A. Per cent S.	B. Per cent S.
0·136	0·077
0·120	0·072
0·136	0·080
0·119	0·076
0·130	0·085
	0·083
	0·081

When the solutions above mentioned are already prepared, this process will be found very expeditious. Having the standard solutions of bichromate and hyposulphite, it is easy to prepare a standard solution of iodine at any time. When once prepared, the solution of iodine keeps correct for months if preserved in a dark bottle and in a cool place.

My sincere gratitude is due to Mr. Vacher, for his kindness to me whilst pursuing these experiments in his laboratory.

NOTES ON THE

EFFECTS OF COLD UPON THE STRENGTH OF IRON.*

By WILLIAM BROCKBANK, F.G.S.

THE severity of the present winter has brought the question of the effects of low temperatures upon the strength of iron very prominently before the public; and it is a curious circumstance that a subject of so great importance should have escaped the attention of writers on iron to such an extent, as that it is either ignored, or dismissed with a few brief remarks or inconclusive experiments, which leave the subject altogether unsettled.

After referring to the observations and experiments on the effects of low temperatures on the strength of cast- and wrought-iron in the works of Sir W. Fairbairn, Dr. Percy, and David Kirkaldy, and pointing out the inconclusiveness of all the experiments hitherto recorded, the writer went on to detail the following experiments, which he had, by the kindness of the several parties named, caused to be made during the severe frosts which have recently prevailed, and which have in all cases been carried out with the greatest care and exactness.

Experiments on the transverse strain of cast-iron bars were made at the works of Messrs. P. R. Jackson and Co., of Salford, and were repeated thrice, with the following results :—

In Mr. Fairbairn's experiments, only one sort of pig-iron was employed. It is now well known that a much sounder and more regular casting can be obtained by a judicious admixture of several kinds of pig-iron; a very probable source of error would thus occur in Mr. Fairbairn's experiments, and this will probably point to the unsatisfactory results he obtained.

The bars employed in the present experiments were made from a mixture of four pig-irons of the highest class, added to some good scrap-iron; they were all poured from the same ladle, and were moulded from the same model, and they were remarkably regular in size and quality, so that the results may be fairly relied on. The castings were all made on Friday, the 30th of December last, and the bars were tested on the following Tuesday, January 3rd, 1871. The machine used was a powerful lever or steelyard, the bars having a 3-foot bearing, and the results were taken with all possible care, and are detailed in the following table.

Experiments upon the transverse strain of cast-iron at low temperature, made at the works of Messrs. P. R. Jackson and Co., Salford, January 3rd, 1871, by W. Brockbank, F.G.S.

The mixture of metals was Cleator hæmatite, Pontypool cold blast, Blaenavon cold blast, and Glengarnock hot blast pig-iron, with some good scrap-iron. All the bars cast from one ladle.

The results show a gradual and considerable decrease of strength in the bars, with the increase of cold below the freezing-point. They also lost their elasticity in a similar degree.

A further trial was made at Messrs. Jackson's Works with similar bars and the same admixture of metals, on January 10th, as detailed in the following table. One bar was cooled to a temperature of 15° by a mixture of snow and salt.

No.	Size of Bar.	Deflection.	Breaking Weight.	Average.	Temperature.
		ins.	lbs.	lbs.	°F.
1	3 ft. long between bearings by 1 in. by 1 in.	0·6875	780	780·00	15
2		0·7500	815	844·30	35
3		0·7600	840		35
4		0·8125	878		35
5		0·7500	845	859·25	52
6		0·6875	855		52
7		0·8125	867		52
8		0·8125	870		52
9		0·8800	893	893·00	70

These experiments are borne out by the general experience of ironfounders, many instances having come to my knowledge during these investigations, a few examples of which may be cited.

(1). I find it a matter of general opinion that pig-iron breaks much more easily in frost than in ordinary temperatures, and that breakages of castings are much more frequent in frosty weather.

(2). In rolling mills, and particularly where chilled rolls are employed, especial care has to be used in frosty weather to warm the rolls before using them, and when in use to keep them carefully covered from the frosty air. If not properly protected and carefully managed, they are found to be very liable to fracture.

(3). Mr. Edgar Gilkes, of Middlesborough, informs me that the cast-iron wheels of the Chaldron waggons of the Stockton and Darlington railway are found to fracture very frequently in frosty weather, and in a severe frost it is sometimes quite a serious matter.

(4). Messrs. Peel, Williams, and Peel had a remarkable example on January 5th (20° F.). A hydraulic cylinder had been cast upon a cast-iron hollow core bar 7 inches in diameter and 1¼ inches thick, coated with 1¼ inches of loam and hay. It was put out in the yard to cool during the severe frost, and when they came to draw the core bar it broke by the mere torsion, and was found to be quite brittle. A portion of this core bar was warmed, and it was then found to have recovered its nature and to be quite strong and tough. The lowest temperature on this date was 19° F., and the casting was exposed to it for many hours. Numerous other examples could be readily furnished if required.

There can, therefore, be no doubt whatever that the strength of cast-iron is very materially lessened by severe cold.

For experiments in wrought-iron I am indebted to many friends, and the results are of similar import. My first experiments were directed to the method adopted by Mr. Kirkaldy, and I soon found that neither by torsion nor gradual tensile strain could the true result be ascertained,

* Read before the Manchester Literary and Philosophical Society, January 10th, 1871.

as the bar almost immediately became heated under the strain, and the effects of frost at once disappeared. The following experiments made by Mr. William Johnson, of the Messrs. Johnson's Ironworks, Bradford, near Manchester, will illustrate this conclusively.

A coil of galvanised wire, 5½ B.W. gauge, was left in the open air for twenty-four hours during severe frost, December 24th, 1870; twenty-four pieces, 1 yard in length each, were then cut off. Of these, six were tested for tensile strength by the direct application of weights, and six for torsion; the same tests were used for the remaining twelve after they had been warmed to about 80°. The results were as follows:—

	Tension.		*Torsion.*	
	At 20°.	At 80°.	At 20°.	At 80°.
	2142 lbs.	2142 lbs.	16½ twists.	14½ twists.
	2114 ,,	2058 ,,	15½ ,,	14½ ,,
	2114 ,,	2086 ,,	9 ,,	13½ ,,
	2142 ,,	2086 ,,	14½ ,,	14½ ,,
	2114 ,,	2128 ,,	16 ,,	12½ ,,
	2114 ,,	2086 ,,	18½ ,,	14 ,,
Total..	12740 ,,	12586 ,,	90 ,,	83½ ,,
Average	2123·3 ,,	2097·6 ,,	15 ,,	13·9 ,,

Thus, in both experiments, the iron tests worse when warm than when frozen. In each case the wire immediately became warm. Mr. F. Monks, of the Whitecross Wire Works, Warrington, also tested wire rods for me with precisely similar results. Finding these experiments to be unsatisfactory, I arranged for a series to be tried by the more rough and ready method of the striker's hammer, which I judged would be more likely to show the true state of the iron in its frozen condition. The result, either of gradual torsion or tension, is to expel the frost there may be in the bar almost immediately, so that in the further progress of the trial there is no difference between bars which were originally either cold or warm.

If low temperatures have any influence in rendering iron weaker or more brittle, the only way in which the amount of such influence can be realised is by a sudden impact, and the striker's hammer was the readiest appliance for the purpose. In the following experiments, great care was taken that the blows should be as nearly as possible of the same force in each trial, and as the experiments were all carefully conducted, and are vouched for by the parties named, they may be fairly relied on as representing truly the facts of the case.

(1). William Bouch, Esq., C.E., Engineer of the Stockton and Darlington Railway, made the following experiment December 29th, 1870, the temperature at the time being about 26°, but it had been as low as 19° over night.

A bar of round iron, 1¼ inches in diameter, of best quality, was taken from the yard, being then coated with ice; it had been exposed to a week's hard frost. It was held over the edge of a smith's anvil, and one blow from a 12 lb. hammer by the striker broke a piece 4 inches long, short off, the fragment flying 12 yards along the floor of the workshop. The same bar was then put into the mouth of a furnace, but not in contact with any flame, for a short time, to unfreeze it. The heat received into the bar was so moderate that a smith could grasp it with his hand. It was then allowed to lie on the floor for some time, until it had quite cooled down to the temperature of the workshop. It was now placed on the anvil, and the same striker as in the first experiment, with the same hammer, gave fourteen blows without causing the slightest fracture, the bar being merely bent about two inches. Mr. Bouch adds that he has, in his experience, met with many cases nearly as convincing as the above.

(2). Mr. Robert Peel, of Messrs. Peel, Williams, and Peel, Manchester, has kindly made for me the two following experiments with boiler-plate iron, as shown by the samples now on the table, viz.:—

No. 1. A strip of boiler-plate of best best quality was taken from the open yard, where it had lain during several days of severe frost, January 5th, 1871; temperature about 20° F.

It was laid across the anvil, and a striker, with a single blow of a 14 lb. hammer, broke off the piece now exhibited.

The fracture shows a very "short" crystalline face, without any appearance of fibre, and is torn and irregular, in remarkable contrast to the sample No. 2, which is from the same piece, viz.:—

No. 2. The remainder of the above strip was slightly warmed to dispel the frost, and then allowed to cool to the temperature of the shop. It required several blows from the same hammer, and bent considerably before breaking, being exceedingly tough and fibrous.

The fracture shows a good fibrous structure, except on the inner side of the curve, where there is a thin crystalline skin.

The difference of appearance in these two fractures is very striking and remarkable, and can only be accounted for by the action of extreme cold.

No. 1*a*. This experiment was made on January 6th; temperature about 26° F. A strip of Low Moor best best boiler plate was taken out of the snow, having lain there during several days of intense frost. It was laid across the anvil, and broken off short with a single blow from a 14 lb. hammer. The fracture is fibrous, but with patches of crystals, especially on the edges of the plate; the general appearance is "short" or "tender," very different from the usual character of Low Moor iron in its normal state.

No. 2*a*. The remainder of the same strip was placed in the drawing office at a temperature of 70°, and allowed to lie there for some hours. It then required six blows from a 14 lb. hammer, the plate being reversed each time, the grain being thus severely bent backwards and forwards, under heavy blows, before it severed. The outer skin still remained in cohesion, and it had to be separated by bending backwards and forwards in the smith's hands. This fracture shows a splendid quality of iron, the fibre being bent in both directions as the blows were alternately reversed. There is a slight crystalline line on the skin of one side.

Mr. F. Monks, of the Whitecross Wire Company, Warrington, has kindly made the following experiments with wire billets, which are the very toughest form of iron manufactured. The wire exhibited is made from one of the same bars, and will clearly show the quality of the iron.

The billets are 1¼ inches square, being in the semi-manufactured form ready for the final heating and re-rolling into wire. They had been lying in the open air several days during severe frost. Experiment tried January 1st, 1871; 10° lowest to 30° highest temperatures.

Three bars were broken in the open air. They failed to break with twenty-two blows with a 15 lb. hammer. A small nick ¼ inch deep was then cut, with three light blows on a "set," in the top of each bar, and at another part of it, after which a single blow sufficed to break each bar.

The bars were then thawed and allowed to cool to the usual temperature, or about 70°. Twenty-two blows were given to each as before, and the same nick was made on one side as nearly as possible like the frozen bars had been treated.

One bar then broke after eleven blows, one after ten blows, and one after six blows.

The frosted bars are more crystalline, and show no signs of fibre; the other bars show a good amount of fibre, and are slightly crystalline in the fractures.

The following experiments with rails were made at the works of the Darlington Iron Company, November 30th, 1869:—

The rails were taken promiscuously from a lot of 1000, all supposed to be of the same quality, weight, and exact

section. It had been found that the rails which were then in course of manufacture for the East-Indian Railways at these works, and which were of a very high quality, failed to pass the required test in frosty weather, whereas in ordinary temperatures a failure was a very rare occurrence. The ten rails were accordingly selected to settle the question whether higher and lower temperature affected the strength of the rails. Four rails were heated up to 120° F.; the other six were tested cold, the temperature of the atmosphere being about 26°.

Test of East-Indian Railway Rails, 82 lbs. per yard, November 29th, 1869, tested by a Falling Weight of 2000 lbs.; Centres of Support, 3 feet 6 inches apart.

No.	No. of blows.	Height of fall. ft. in.	Permanent set.	Temperature.	Remarks.
1	1st blow	5 0	7-16ths	120°	Not broken.
	2nd ,,	5 0	3-4ths		
	3rd ,,	7 0	—		
2	1st ,,	5 0	3-8ths	Do.	Ditto.
	2nd ,,	5 0	13-16ths		
	3rd ,,	7 0	—		
3	1st ,,	5 0	3-8ths	Do.	Ditto.
	2nd ,,	5 0	13-16ths		
	3rd ,,	7 0	—		
4	1st ,,	5 0	3-8ths	Do.	Ditto.
	2nd ,,	5 0	7-8ths		
	3rd ,,	7 0	—		
5	1st blow	5 0	3-8ths	26°	Broke with 2nd blow.
	2nd ,,	5 0	broke		
6	1st ,,	5 0	3-8ths	Do.	Passed test.
	2nd ,,	5 0	5-8ths		
7	1st ,,	5 0	3-8ths	Do.	Broke with 2nd blow.
	2nd ,,	5 0	broke		
8	1st ,,	5 0	3-8ths	Do.	Ditto.
	2nd ,,	5 0	broke		
9	1st ,,	5 0	broke	Ditto with 1st blow.	
10	1st ,,	5 0	3-8ths	Ditto with 2nd blow.	
	2nd ,,	5 0	broke		

At 120°, all the bars stood two 5-foot blows and one 7-foot blow.

At 26°, only one bar stood two 5-foot blows, three broke at the second 5-foot blow, and one at the first 5-foot blow.

At 60°, all would probably have passed the test easily, many thousands having previously done so from the same lot.

It will therefore be seen that the results are in perfect agreement in all these experiments, showing that bar-iron, boiler plates, wire billets, and rails are most materially weakened by the action of intense cold, losing all their toughness, becoming quite brittle under sudden impact, and having their structures changed from fibrous to crystalline.

Similar instances could be given in illustration of this in the daily practice of engineering. In large works, the breakages of wrought-iron are very considerable during frosts. Quarrymen find that their chains are very liable to fracture from the same cause; and doubtless the numerous accidents of failing tires in our railways may be attributable to it. In many cases, however, the contraction of iron must also be taken into account, as it is a serious item.

In conclusion, I think it cannot be doubted, after the above recital, that iron does become very much weaker, both in its cast and wrought state, under the influence of low temperatures. This subject is one of such paramount importance, that a careful series of investigations ought to be undertaken by one of our scientific bodies, to ascertain the precise nature of the changes which are thus shown to take place, as there is herein an item which materially affects the stability of all iron structures during frosty weather, and which has not hitherto been adequately recognised.

ON THE

RELATION EXISTING BETWEEN CHEMISTRY AND MINERALOGY.

By Dr. C. RAMMELSBERG.

NOBODY doubts, nowadays, that all the properties of a substance are very closely connected together; and since isomorphism was discovered to exist, some fifty years ago, every chemist knows that the crystalline form of a substance is intimately connected with the chemical nature of the body. The crystalline form is the result of a juxtaposition of molecules according to properly-defined symmetrical directions. That form defines, in the interior of the body, the directions according to which cleavage takes place, while differences of hardness, as well as other physical properties, depend also upon the specific crystalline form; while we need not doubt that the optical properties of the bodies are very closely allied to the form just alluded to, because we know that crystals possessed of one optical axis obey totally different laws of symmetry than do crystals having two optical axes; while it is also plain that crystals belonging to the regular system, in which we do not distinguish upper or under, front and back, left and right side, are on all sides symmetrical and singly refractive. Is not circular polarisation bound to, and intimately connected with, the existence of peculiar forms of the crystals, on which we distinguish a difference of right and left? All agree that the thermal, electric, and magnetic properties of bodies are connected with the geometrical figures they exhibit, while the volume-density (specific gravity) and specific heat of bodies are most intimately connected with the chemical nature and properties thereof. The perception that there exists of necessity a connection between all the properties of a body, and the fact that the sum total of the properties is required for determining the difference of that body from all others, is not of very remote date. It was for a great length of time the criterion of chemistry that it only occupied itself with the material nature and combinations of substances, while chemists only studied the composition and reaction of bodies, and cursorily added thereto some few particulars on colour, fusing-point, boiling-point, and specific gravity. In our days, however, this is not deemed sufficient; and it is by far more important for the thorough building-up of science that a limited number of substances should be thoroughly studied and investigated in all their relations and all their properties, than that a very large number of bodies should be only imperfectly and fragmentarily known, involving the additional trouble of having to return to complete these studies afterwards. It is the especial duty of the chemist to study bodies in all their relations; and therefore, according to what is accepted as a rule, these properties embrace those termed geometrical, physical, and chemical, and only after having mastered all these is it possible to say that we know the substance. It is, however, clear that it is beyond the limits of the ordinary capability of the human mind to master all the subjects thoroughly; while, moreover, not all the properties are of the same value, it having been found that by far the most important properties of substances are those termed chemical and geometrical, next to which stand the optical properties. Crystalline form and composition are therefore to be investigated in the first place, and jointly because they are the foundation stone, as it were, of the whole of the rest of the properties. A chemist ought to be just as expert in measuring and calculating the angles of crystals as he is capable of making analyses and of testing substances. The late Dr. Mitscherlich became the discoverer of isomorphism and heteromorphism because he was a crystallographer, and M. Pasteur would never have made his brilliant discoveries if he had not known that the rhombenoctahedron yields two enantiomorphous tetrahedrons. I think it is very desirable that our young chemists should become well acquainted with crystallo-

graphy, which is too much neglected at present, so as to enable them to study the relations existing between chemical constitution and crystalline form. If it be alleged, against this proposition, that many other celebrated chemists, the late Berzelius, for instance, never gave any proof of his acquaintance with crystallography, my reply thereto is that, far from being any addition to, it rather was a defect of his merits; and, moreover, times have so changed that we may safely assert that, in the first place, universal chemists will be no more heard of, and, secondly, no sound knowledge of chemistry can exist without crystallographical knowledge combined. Mineralogy is truly a German science, which has sprung into existence from mining and metallurgical operations; for a long time this science was in a rude state, and bore an empirical character, only taking cognisance of a very few external properties, remaining in this condition even after Werner's days. Romé de l'Isle and Hauy discovered the mathematical laws of the crystalline forms, while the latter, very materially aided by Vauquelin, studied and investigated the physical properties of the crystals, which were chemically, also, analysed by the last-named *savant*. But the parties just named, and their successors—viz., MM. Weiss, Mohs, and many others—were only capable of studying minerals one-sidedly, because they were only crystallographers; and those on the other hand, who, preceded by Klaproth, investigated the chemical nature of minerals, were unacquainted with the methods of studying the geometrical properties of these bodies. This state of affairs has been at the root of an endless number of errors in mineralogy; because, what had been studied by one, and analysed under the same name by the other, frequently turned out to be thoroughly different substances, and the division of labour has in this instance impeded and greatly impaired the progress of mineralogy.

What are minerals? Chemical combinations which, either sporadically or in large masses, constitute the solid structure of our globe. These compounds may, and can be artificially prepared, as is the case with all so-called artificial compounds; these compounds are formed without our aid, just as is the case with those formed in organised bodies.

Is there any difference between the crystals of sulphur deposited from solutions and those obtained from Sicily and from the Solfatara? Is the oxide of iron obtained from the fumaroles of the lava of the Vesuvius different from that which has been obtained in crystals artificially? Is the felspar obtained by some processes of copper smelting different from the native mineral? All these native compounds may be obtained synthetically by artificial means. The materials mineralogy has to deal with are limited to a small number of chemical combinations; the properties we mineralogists have to investigate and the methods of research are exactly identical with what obtains in chemistry. Nobody is, in the true meaning of the word, a mineralogist, unless he be equally capable of making a chemical analysis of his minerals as of determining crystals exactly. It was a curious blunder made by M. Mohs, when he tried to prove that minerals, like animals and plants, were only to be classified according to their external appearances, and that chemistry had nothing whatever to do with them. This opinion Mohs, a celebrated and very eminent crystallographer, was led to because he know nothing whatever of chemistry, and because the discovery of isomorphism had remained unknown to him; his so-called natural history mineral system is perfect nonsense. But while we speak in these terms about Mohs, we are in justice bound equally to condemn the error of the late Dr. Berzelius, who tried to set up a purely chemical mineral-system, simply based upon the chemical composition of the minerals. It is sufficient to say that heteromorphism alone is sufficient to prove the utter impossibility of such a proceeding.

We have at present a so-called mixed system, that is to say, a more or less successful plan of grouping minerals in accordance with crystalline form and composition. Might it be allowed to call chemistry and mineralogy one science? It is very possible that, by so doing, many a so-called mineralogist, who knows nought about chemistry, might feel offended. Even if the distinctive name of mineralogy be preserved, it is clear that it will be entirely absorbed by chemistry, because the mutual relations of minerals towards each other, and their modes of formation and decomposition have long since become treated as separate sciences under the names of geognosy and geology. It was said, very many years ago, by the late Dr. Berzelius, "mineralogy is the chemistry of those compounds which are met with in the native state." The domain of chemistry is, however, far more extensive; but the properties we determine for every single substance are the same, and so are the methods and means we employ. Since the last quarter of a century, chemistry has made enormous progress, not only in the collection of a mass of facts, but also in speculative matters. It is self-evident that this progress has operated advantageously on mineralogy; and it is certainly the duty of all mineralogists to apply the facts and discoveries of chemistry, obtained and made in every direction, to their department of science. Some of the views formerly held by chemists have been entirely modified; but it is superfluous to say that the views held at the present day are simply due to the enormous and almost incredible increase of facts.

The following are only a few, yet essential, portions of the present magnificent structure of chemistry:—The full recognition of the law of Avogadro; the sharply-drawn distinction between the idea of atoms and molecules; the doctrine of atomic weights; the quantivalence and equivalence of the elements; the analogy of the constitution of all acids, bases, and salts. I need not put the question whether there are at present living any chemists who yet hold the old views? Suffice it to say that no chemist of any standing would dare to defend these views; but, when chemists adopt certain views, theories, and hypotheses, because these better agree with facts, nobody also considers that these views are anything else than a step forwards in the right direction, which in future may give way to better. That which the labour, zeal, and acumen of a large number of industrious scientific men has built up during the past twenty-five years must undoubtedly be designed *progress*. How is it that we meet here and there mineralogists who speak with disdain of these things, and who, declining to have anything to do therewith, stick to the old views, taking these new-fangled ideas as so much useless change? Just as in the domain of chemistry there is a predilection for cultivating and extending the organic portion, so in mineralogical science are geology and geognosy preferred; while, as regards the mineralogy proper, only a few cultivate it, and these are chiefly occupied with the morphological, not with the chemical portion. It is clear that these mineralogists will only apply to their purposes such researches of chemistry as directly relate to minerals; but they are incapable of understanding the real bearing of modern chemistry, and of making such changes in the science they cultivate as are rendered necessary by the progress of chemistry. The chief objection made is against the formulæ; these, as regards minerals, were, since they were first introduced by the late Dr. Berzelius, either empirical or rational. The former only indicate the kind and the relative number of the elementary atoms met with in the compound; and, as the old atomic weights are yet in use, the empirical formulæ are also those of older date. $CuFeS_2$ = copper pyrites, $CaSiO_3$ = wollastonite, $CAAlSi_2O_8$ = anorthite, $BaSO_4$ = heavy spar, are even yet the empirical formulæ of these bodies. It is evident that the changes made in many of the atomic weights has brought about considerable changes of formulæ:—Fluor spar = $CaFl_2$, instead of CaFl, as formerly; leucite = $K_2AlSi_4O_{12}$, instead of $KAlSi_4O_{12}$; orthoclase = $K_2AlSi6O_{16}$, instead of $KAlSi_6O_{16}$, &c.

As regards the rational formulæ, the matter is different, because they expressed a definite view as regards the

mutual arrangements of the atoms in the molecule, as it was formerly surmised that the oxy-salts were the products of the addition of base and acid, the formulæ were arranged accordingly. $CaO+SiO_2$, $BaO+SO_3$, also—

$(2CaO+SiO_2)+(2Al_2O_3+3SiO_2)$ = anorthite,

were the expressions at one time generally in use as the result of a hypothesis universally adopted in chemistry. This hypothesis has been set aside by chemists, not for the mere sake of change and novelty, but upon sound grounds; another hypothesis has been substituted, and according to it rational formulæ are now made up. Whether we write the formula of sulphate of baryta—

$$\left.\begin{matrix}Ba\\(SO_2)\end{matrix}\right\}O_2, \text{ or } Ba.O_2.(SO_2),$$

or any other way, we desire to express thereby that one molecule (two atoms) of oxygen is combined on the one hand with an atom of barium, and on the other hand with the atomic group SO_2 (the radical of sulphuric acid), exactly agreeing with the bodies—

$$\left.\begin{matrix}H_2\\(SO_2)\end{matrix}\right\}O_2=H_2.O_2.(SO_2) \quad \text{and} \quad \left.\begin{matrix}H_2\\Ba\end{matrix}\right\}O_2=H_2.O_2.Ba;$$

that is to say, the acid and the base, by the reaction of which upon each other, and elimination of the equivalents, $H_2=Ba$ or $H_2=SO_2$ is produced. In the same manner, carbonate of lime is represented as—

$$\left.\begin{matrix}Ca\\(CO)\end{matrix}\right\}O_2=Ca.O_2.(CO),$$

and silicate of lime as—

$$\left.\begin{matrix}Ca\\(SiO)\end{matrix}\right\}O_2=Ca.O_2.(SiO_2).$$

Everyone will admit that these views are distinct from those formerly held. Since chemists have adopted these methods of expression, heavy spar cannot be indicated as $BaO.SO_3$, wollastonite not as $CaO.SiO_2$, calc spar not as $CaO.CO_2$; because, whoever would apply these formulæ nowadays in mineralogy, ignores the present advanced state of chemistry altogether. We may say, however, that there is no fear that this will happen, because a mineralogist ought to understand enough of chemistry to know the grounds upon which the changes have been made by chemists. Now and then, we hear it said by mineralogists that it is not yet proved whether silicic acid anhydride is SiO_2 or SiO_3, because the isomorphism of the double fluorides of Si, Ti, Zr, and Sn does not carry to them sufficient proof for SiO_2. How is it that they do not know that the formulæ, $SiCl_3$, $SiFl_3$, do not harmonise with the specific vapour-densities of these bodies? Are not the discoveries of silicide of hydrogen, and of those compounds of Si, H, and O which are analogous to organic compounds, proofs of the equivalence of carbon and silicium? No chemist of repute will, therefore, seriously use the formula SiO_3. Notwithstanding the ready adoption of new facts by many, it appears that it is very difficult for older men, and especially for mineralogists, to give up their old views; but, as well observed by Professor Streng, they are, however reluctantly, compelled to follow and do suit and service to the new facts brought to light by the chemists.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from p. 29.)

LECTURE IV.

WE had occasion last time to notice the effect of the atmosphere on processes of fermentation in several instances. I mentioned, among other things bearing on that question, an experiment of Gay-Lussac, in which he squeezed some very ripe berries of the grape under mercury, and kept them, with due precautions for the exclusion, as far as he knew, of everything except the grape-juice; he kept this expressed juice for some time quiescent, and then introduced a bubble of air, or a bubble of oxygen, the active substance of air, but he subjected the air or the oxygen, before introducing it into this juice, to various strong influences, which must have destroyed any vital organism in it; and he found that the mere addition of the air to the quiescent juice caused a process of fermentation to commence and a formation of organisms to begin, that they developed themselves, and that the liquid fermented in the usual way. The fact of the fermentation commencing is, if we bear in mind the general results of M. Pasteur's researches, to be attributed to the presence in the mercury or in the grape-juice, or somewhere or other in the substances present, of bodies which, by the mere access of oxygen, were stimulated so as to develop themselves into these little vital cells. It is now known, I may say, that there are in mercury, unless it is purified with extraordinary precautions, always present some such organisms, capable of developing themselves under such influences; and, it is probable, I will not say more than that, for I do not know, that in the grape-juice there may also be similar germs present. The functions of oxygen appear from that experiment—which has since been confirmed by other observers—to be essential, at all events, to the initiation of the process, and there is, in that respect, a remarkable analogy, which I think is interesting to recall to mind, with the action of oxygen on other bodies, as shown by an experiment made by Humboldt many years ago. He got some grains of wheat from Egyptian mummies, which had been so long at rest that they were not inclined to grow; in fact, they could not be got to grow in the ordinary way. However, he stimulated them to activity by immersing them in a little chlorine water. It is well-known to chemists that chlorine in the presence of water does oxidise, or cause the oxygen to separate and pass over to common organic substances capable of combining with it. Humboldt actually stimulated these sleepy wheat grains to life, so that they grew and germinated, and their descendants are still in existence, by the mere action of oxygen developed in that way.

In the processes of wine-making and wine-keeping, the presence of air is one of the most important matters which have to be considered, and there has prevailed, and I ought to say there still prevails, to a certain extent, a difference of opinion regarding the functions of oxygen in these processes. On the one hand, it is known, as a matter of fact, that processes of fermentation are performed under conditions such as that air has access to the substance. No actual wine or beer-making has yet been performed on a large scale on such conditions as to exclude oxygen. On the other hand, the experiments of Gay-Lussac established clearly that it is necessary. In some cases, however, in wine-making, it has been thought desirable to facilitate the access of air to the substance; while other wine-makers think, on the contrary, that in the first process as little air should be present as possible; but there has always been some. The juice first expressed from the grapes has been very carefully examined with regard to the gases contained in it. If air has access to it, it is always necessary to know, in order to judge whether the air acts upon it, whether the air is dissolved by it, and whether, if dissolved by it, it is still to be found in the grape-juice as such, or whether it has undergone combination. Now, every case of the examination of must, or fresh grape-juice, which is not fermented, has shown that it contains a considerable quantity of gas, but no case has been established of free oxygen being present in it. Carbonic acid gas is present in it in a considerable quantity, and also nitrogen, in proof that air had had access to it, but the oxygen which was taken up at the same time with the nitrogen from the air, was not to be got out from that must again. It had been taken up, and it had entered into combination with the substance, so that all the oxygen present was actually combined chemically with it. In that respect a good many observations have been made by

* The Cantor Lectures. Delivered before the Society of Arts.

various chemists, but I ought especially to quote those of M. Pasteur, which are exceedingly careful and valuable. He has shown that this substance not only eats oxygen, but digests it. The oxygen is not to be found in it as such. It is only present in the form of a compound, which is formed by its action on the organic matters there present. Then, when the wine-juice has been expressed, and when it has been allowed to remain some time in a suitable place, so as to undergo fermentation, with a considerable variety of treatment in different places with regard to air, for, in some places it is thought desirable that the fermentation should be allowed to take place in open vessels, or in vessels to which the air can have access as freely as possible, whereas in other cases special care is taken to cover as completely as possible the vessels in which the fermentation is taking place, so that the air may have as little access as possible to the fermenting substance,—and I believe it is impossible to give any one general rule with regard to the best process for all cases of fermentation, because the materials which are subjected to fermentation vary so considerably; they differ from one another in their composition so materially, and there are also other circumstances which are different,—for instance, the temperature, which has an important influence. Not only is the temperature in some localities higher than in others, but other circumstances are also different, and it would not be right to say, because air is found to be perfectly useless in some well-established cases during fermentation, that for that reason it ought to be excluded, or even that it may be excluded, in all other cases of apparently similar fermentation. As far as a general rule can be laid down from present experience, I think it does appear certain that oxygen plays no part in the process after the first expression of the juice. Once the fermentation has commenced, it appears to go on as well if air is excluded from the substance as if air has access to it. There is, however, one circumstance which is considered by persons of considerable experience to be important in this matter, and which I ought, therefore, to mention, viz., that when fermentation takes place at a low temperature—and some fermentations are, with great care, kept at a low temperature—the products are found to be superior if the whole process is carried on, the temperature being kept exceedingly low, and, in those cases, it appears that an open vessel is certainly not in any degree detrimental. It is customary, in fact, to use an open tub when the temperature is low; and, on the contrary, it is usual to use a partially closed vessel, of course allowing for the escape of carbonic acid, when the temperature is comparatively high. When the first vinous fermentation has completed itself, it is customary, in the wine-growing countries, to put the still active liquid into casks, and the slower process of fermentation then goes on, which lasts a considerable time. During this second fermentation, there is very much the same kind of condition present in the first, and there is always formed, in this subsequent fermentation, a considerable quantity of deposit, which is afterwards removed with much care; either the supernatant liquid is carefully decanted, or, in some cases, it is removed by a process of rough filtration. The subsequent treatment of the wine, I mean the keeping of it in casks or cellars, and the subsequent keeping in bottles—and these two processes of keeping it in casks and keeping it in bottles are quite distinct,—are not usually considered as forming part of the process of wine-making. It appears, however, from the investigations of M. Pasteur, that changes take place in the composition and the materials by these processes, which really are as essential to the composition of the product as any other part of it, and that they ought to be considered as later parts of the process of wine-making. In fact, the process of wine-keeping is, in theory, not to be separated from the process of wine-making, the keeping being a process making it more perfect than it was when first turned out of the fermenting vessels. Common experience corroborates that in a very remarkable way. Everybody knows the difference there is between new and old wine, and the changes which takes place when the wine is being kept constitute certainly one of the most important parts of the general subject of wine-making. Wine, when its fermentation has been completed, is found to absorb air with considerable rapidity and avidity, and when endeavours are made to get out from this wine again the air which has been dissolved in it, it is found that some kinds of wine allow it to go, or part with it again, whilst other wines do not; and in this respect, a distinctive test is found between the qualities of the wine; for by observing this difference in the facility with which they give up the air which they have dissolved, and by comparing that with the qualities of wines in each case, a regeneralisation has been arrived at. In this matter I speak upon the authority of others, for I have not confirmed it by my own observations. But all that I do know fully corroborates it. The rule is this, that whereas low-class wines, which people will not pay much for, give up again almost completely the air which they have dissolved, superior kinds of wine do not give it up again, they only give up the nitrogen, and hold the oxygen fast. The oxygen, which is dissolved in both cases, is held firmly, or is digested by the high-class wines; but it is not digested, but simply eaten by low-class wines. Observations have been made in this direction by a great many observers, especially Berthelot and Pasteur, to whom we owe most decisive results in this respect.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

February 2nd, 1871.

Professor WILLIAMSON, F.R.S., President, in the Chair.

THE following gentlemen were elected Fellows:—R. J. Friswell, R. F. Humiston, M.D., A. H. Mason, J. R. Tustin.

Professor FRANKLAND, F.R.S., read a paper "*On the Development of Fungi in Potable Water.*" He began by alluding to the experiments Dr. Heisch had made some months back with waters contaminated with sewage matter. When to such waters some sugar was added, very soon a kind of fermentation ensued, and a rich fungoid growth made its appearance. Professor Frankland has now repeated and extended those experiments and arrived, with one or two exceptions, at the same results. But, in the course of his researches, he encountered some reactions which appeared at first difficult to explain. During a visit to Mr. Hope's irrigation farm at Romford, on the 26th of November last, he collected a sample of effluent water from one of the drain outfalls. This water consisted of the sewage of Romford, which had percolated to the tile drains through some four or five feet of loose gravelly soil. It was clear,—but that it still contained a considerable proportion of unoxidised sewage was evident from the following results which it yields on analysis:—

100·000 parts contained—

Total solid impurity in solution ..	85·600
Organic carbon	0·844
Organic nitrogen	0·233
Ammonia	0·040
Nitrogen as nitrates and nitrites ..	1·143
Total combined nitrogen	1·419
Chlorine	9·300
Temporary hardness..	27·950
Permanent ,, ...	20·600
Total ,, ...	48·550

The proportion of organic carbon was three times, and that of organic nitrogen ten times, as great as that found

in unpolluted water, whilst the comparatively large proportion of ammonia showed that the oxidation of the organic matters was still incomplete. Nevertheless, this water, when mixed with the proper proportion of sugar, and maintained at a temperature of about 70° F., remained perfectly transparent for weeks. The result of the next experiment was still more remarkable. Two samples of the Grand Junction Company's water were mixed with sugar in the usual way. One of them was drawn from a foul uncovered cistern over and within a water-closet; the other from a clean slate cistern, in passing out of which the water filtered through some 30 or 40 lbs. of animal charcoal. The water from the foul cistern remained transparent for weeks, whilst that drawn from the clear cistern through animal charcoal soon became turbid and in three days had produced abundant fungoid growths. Remembering Mr. Heisch's statement that filtration through *well-aired* animal charcoal is effectual in preventing these growths even in foul water, Professor Frankland now passed a rapid current of air through the filter for about fifteen minutes, and then left it exposed to air for six hours. The result, however, was the same as before; Grand Junction water drawn through it immediately after aëration, behaved exactly as before when mixed with sugar. These experiments seem to indicate that the presence of a phosphate was in some way connected with the production of the fungoid growths and other living organisms, for it is known that water dissolves traces of calcic phosphate from animal charcoal, and this supposition was strengthened when Professor Frankland found that the effluent water from the sewage farm at Romford contained no detectable trace of phosphoric acid, the plants and poor soil of this newly cultivated farm having, doubtless, removed all phosphates from the percolating sewage. The hypothesis of the dependence of the fungoid and other growths upon the presence of phosphates was further supported by the results of the following experiments:—

A sample of the Grand Junction Company's water mixed with sugar remaining perfectly clear for twelve days, minute quantities of ammonic nitrate and sodic phosphate were now added; three days later, it swarmed with very active vibrios and cells with bright nuclei, subsequently very luxuriant branched fungoid threads developed themselves, and the mixture emitted a strong ferment odour, which, a few days later, became horribly offensive.

A sample of the Southwark Company's water mixed with sugar remained for nineteen days perfectly clear and transparent; small quantities of ammonic nitrate and sodic phosphate were then added. In a few days it was crowded with vibrios and monads, and later it was found to contain the characteristic mycelial fibres.

The usual proportion of sugar was added to a sample of water collected at the Cerney Springs near Cirencester; it remained clear for eight days, and was then mixed with traces of ammonic nitrate and sodic phosphate; it continued turbid ever afterwards, and soon became filled with swarms of vibrios and fine branching tubular fungoid threads; the water subsequently became brownish and emitted a very offensive odour.

These experiments show that potable waters, which stand the sugar test perfectly, become entirely changed in their behaviour with this test when they are mixed with traces of ammonic nitrate and sodic phosphate; and the following experiments prove that it is the phosphoric salt which alters their behaviour in this respect:—

A sample of the Lambeth Company's water, after admixture with sugar remained perfectly clear for nineteen days; ammonic nitrate was then added; after the lapse of several weeks the clearness of the sample had not been disturbed.

Canterbury deep well-water, softened by Clark's process, remained perfectly clear during twenty-three days after admixture with sugar; traces of nitrate of ammonia were then added, but, after the lapse of two months, it was still perfectly transparent and unchanged.

It is thus evident that the addition of minute traces of a phosphate, either as sodic phosphate, white of egg, or animal charcoal, at once determines these fungoid growths in saccharine water, which before exhibited no tendency to develop them.

An important question now presented itself. Are the germs of these organisms necessarily contained only in the waters which develop fungoid growths, or are they present in the atmosphere? The answer to this question is given by the following experiment:—

Small quantities of potassic chloride, ammonic nitrate, sodic phosphate, and sugar were dissolved in distilled water previously boiled for many hours with caustic soda and potassic permanganate, and afterwards again distilled. Just before solution the solid ingredients were strongly heated in a platinum spoon over the flame of a spirit-lamp; the potassic chloride and sodic phosphate to redness, the ammonia nitrate until a considerable proportion had decomposed into nitrous oxide and water, and the sugar until, after melting, it began to turn brown. This solution was placed in a stoppered bottle, as in all the previous experiments. After a few days' exposure to a temperature varying between 60 and 70° F., a magnificent mycelium of the characteristic description began to grow, and was soon followed by several others. The liquid was also crowded with very minute moving organisms, probably monads. A specimen of real sewer fungus was examined side by side with this and found to be very similar in appearance, but more transparent, and somewhat smaller.

It is thus evident that the purest water which can be obtained in contact with the air yields splendid crops of this sewage mycelium, if it be supplied with the necessary soil, and, further, that the sugar and salts just named contain all the elements necessary for its development. Of these elements, phosphorus is essential, for, in a solution made at the same time, exposed to the same conditions, and containing the same substances, *minus the sodic phosphate*, no trace of mycelium or of any other organism made its appearance during the nine weeks it was under observation.

The presence of germs in a sample of water is therefore insufficient in itself to produce Mr. Heisch's reaction when sugar is added, and then a short (probably a momentary) contact with air is sufficient to impregnate any sample of water with the necessary germs, which develop, on the addition of sugar, only in the presence of a phosphate. The reaction is, in fact, an exceedingly delicate test for phosphoric acid. It would probably defy the powers of the most expert chemist to detect, in 2 ounces of water, the phosphoric acid introduced by the addition of a single drop of a dilute solution of albumen; yet these atmospheric germs find it out, appropriate it, and, by their growth, reveal its presence. Professor Frankland then described some experiments in which water, sugar, sewage matter, and the necessary salts, were kept in dark or obscure places at the temperature of the body. He found that these conditions were favourable for the development of bacteria, vibrios, and similar organisms, but unfavourable for fungoid growth.

From all observations, which were only partially given here, Prof. Frankland drew the following conclusions:—

1. Potable water mixed with sewage, urine, albumen, and certain other matters, or brought into contact with animal charcoal, subsequently develop fungoid growths when small quantities of sugar are dissolved in them and they are exposed to a summer temperature.

2. The germs of these organisms are present in the atmosphere, and every water contains them after momentary contact with the air.

3. The development of these germs cannot take place without the presence of phosphoric acid, or a phosphate or phosphorus in some form of combination. Water, however much contaminated, if free from phosphorus, does not produce them. A German philosopher has said "*ohne Phosphor kein Gedanke.*" The above experiments warrant the alteration of this dictum to "*ohne Phosphor gar kein Leben.*"

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 24th, 1871.

E. W. BINNEY, F.R.S., F.G.S., President, in the Chair.

MR. BROTHERS, F.R.A.S., exhibited a drawing from the fine photograph of the solar corona, taken by him at Syracuse. during the late total eclipse of the sun.

Mr. W. B. JOHNSON, C.E., gave an account of two cases of very narrow escapes from serious accident to railway trains, in consequence of the present faulty system of arrangement of the points or switches.

Dr. JOULE, F.R.S., &c., read the following letter, dated January 21st, 1871, which he had received from Mr. William H. Johnson, of Bowdon.

"Since the last meeting of the Philosophical Society I have made some further experiments on the 'Effect of Cold on the Strength of Iron.'

"In these I have maintained a nearly fixed temperature, and thus avoided to a great extent the error occasioned by the rise in temperature, consequent on sudden torsion.

"January 11th. A piece of a charcoal wire rod, 0·237 of an inch diameter, gave the following results:—

	1st.	2nd.	3rd.
At about 40° F.	20 twists	19 twists	17 twists.
Adjacent 6" at temperature of melting zinc.	10 twists	9 twists	7½ twists.
		4th.	5th.
Twisted very slowly, surrounded by salt and snow		19¼ twists	16 twists.
Adjacent 6" at about 40° F.		15 twists	—

"The twisting under salt and snow was performed so slowly, each experiment lasting a quarter of an hour or more, that the temperature cannot have been affected by the torsion. The same care was taken at the temperature of 40° F.

"The great diminution of strength at the melting point of zinc is remarkable.

"I take the liberty of communicating these results to you, as unfortunately I shall be away at the next Meeting, and thus shall not have an opportunity of seeing you."

Mr. BROCKBANK remarked that these experiments did not affect the conclusions stated in his paper read at the last meeting. He believed that the strength of iron under torsion was most affected by the heat developed by the twisting, and that the cooling mixture employed by Mr. Johnson would have the effect of making the wire stand a greater number of twists by counteracting the excessive heat produced by the torsion.

Mr. BROCKBANK, F.G.S., exhibited a drawing of the machine used by him in his experiments on the strength of cast-iron at different temperatures.

NOTICES OF BOOKS.

The Annual Report, for the Year 1870. By CHARLES A. CAMERON, Ph.D., M.D., City Analyst. Dublin: Joseph Dollard. 1871.

ALTHOUGH only a pamphlet of ten octavo pages, this little volume bears ample testimony to the fact that to Ireland's capital strongly applies what is often said of foreign countries here, "they manage things better there;" indeed, the few pages before us contain a mere skeleton of the enormous amount and great diversity of labour performed by Dr. Cameron during the last year in his capacity as analyst to the City of Dublin. The catalogue contains the following headings of subjects:—Specimens of Food Analysed, including milk, bread, butter, flour, sugar, coffee, wine, porter, whisky; Poisonous and Adulterated Confectionery (113 samples in all); Water Analyses; Petroleum Analyses; Reports (14) on various Sanitary Subjects; Sewage Analyses. Acting as Officer of Health during Dr. Mapother's absence in America; inspection of chemical works, manure factories, &c.; attendence at law courts (106); attendance at Public Health Committee (52 times). Meat, fish, fruit, and vegetables condemned during the year. Without entering into further details, it appears that at Dublin they thoroughly understand, value, and carry very efficiently into effect, what is very properly termed *administration de la salubrité et sureté publique*, a branch of that portion of local government which in its entity is so fully treated of by Von Mohl in his celebrated work on "Polizeiwissenschaft." The excellent example given by Dublin deserves to be imitated elsewhere, for the want of a good and efficient system exists in many English towns and not the least so in this metropolis.

CORRESPONDENCE.

CHLORALUM AS A DISINFECTANT.

To the Editor of the Chemical News.

SIR,—The country is fairly steeped in contagion! Small-pox, scarlatina, typhoid, and typhus in man; the lung plague, foot and mouth diseases, and hog cholera in animals, are all raging, and we can scarcely open a newspaper or scientific journal without finding reference to self-propagating maladies, or means suggested for their control. Dr. Budd is meeting with well merited praise. Professor Lister has brought the "antiseptic treatment" into repute, and we hear of news of the antiseptic treatment of fevers. You, sir, can congratulate yourself on the prominence given to the health-preserving powers of carbolic acid, and Dr. Sanderson leads the van in scientific demonstrations of the nature of contagia. It has been recognised that the noxious particles are floating in air and water. Professor Tyndall's electric light has awakened the public mind to dangers surrounding every human being, and a complete revolution in medical and popular opinion has been brought about by Pasteur and his disciples.

Under the circumstances, I do not think the discussion you have permitted in the columns of the CHEMICAL NEWS is out of time or out of place. Our great aim, however, should be to divest the discussion of all that does not properly pertain to it.

Mr. Carter Bell has drawn attention to an article on "Disinfectants" in Ure's "Dictionary," in which the chloride of aluminium is mentioned as an antiseptic. In thanking him for this reference may I ask him to refer me, if possible, to any work in which the therapeutic properties of this agent are described. All I have sought has been knowledge on the subject, and Mr. Bell must not suppose I am specially anxious to lay claim to discoveries. Whether I am the first or the last in a good work matters not to me. My great aim in all that I have done during my professional life has been the extirpation of contagious diseases. I believe, it may be in error, that no part of the work I have accomplished has been of equal importance to the introduction of the chloride of aluminium in medicine. It is now an article of commerce, and one of a very small number, the only one, under many circumstances, available for the effectual destruction of fever poison. My opinion is sure to be confirmed by the "prolonged observations" desired by Dr. Ballard, and no attempts at disparagement nor injudicious advocacy on my part, should I have been guilty of such, can affect the issue.

Mr. Carter Bell has attempted "to remove the smell from alkaline sulphides by chloralum." He used the "yellow sulphide of ammonium" as a substitute for "a

badly smelling midden or cesspool," and would lead us to infer that sulphide of ammonium is the active principle, if I may use the expression, of the fetid contents of such receptacles. I have heard of another gentleman, a physician and a chemist, trying this extraordinary experiment.

Need I, in the columns of the CHEMICAL NEWS, repeat what I have stated elsewhere, that sulphide of ammonium is *not* the enemy we purpose attacking with disinfectants, and that it is not the main principle to counteract in dealing with putrefying organic substances? The chloride of aluminium acting like an acid decomposes the sulphide, and sets free sulphuretted hydrogen.

Disinfectants or disease-germ destroyers should he used promptly to kill the poisons emanating from fever patients. Chloralum does this, and completely arrests putridity so as to prevent the formation of badly smelling compounds, the existence of which rather denotes the decomposition of organic poisons.

It is true that a virus in a partial state of putrefaction may have even greater activity than before decomposition sets in, but complete putresence annihilates the poisonous principle. This I have proved with the virus of pleuro-pneumonia so often kept in a bottle by cowkeepers for purposes of inoculation. When partially putrid, from the absorption of putrid elements into the system of the inoculated animals, simultaneously with what virus is left unchanged, it is the cause of a high mortality. It may be kept so long as to be quite powerless.

Mudie's disinfectant we are told is sulphate of iron. This very useful salt, under its proper name, is available for many purposes in dealing with contagious or other diseases. We know its value; I cannot help thinking that, if Mr. Carter Bell wishes it to be more extensively used than it has been by the sanitarian, it would be well to follow the adage of calling "a spade a spade."

Chloralum is the chloride of aluminium, and it is now made of uniform strength, containing 1500 grains of the salt to the pint of solution; or in the form of powder, mingled with the usual bases, silica and sulphate of lime, forming a 30 per cent disinfecting powder, without odour, and of great efficacy. We know what we are dealing with here; and let us hope that those ill-natured monsters, prejudice and self interest, may not bar the way to an early solution of the problem as to which of the disinfectants may be safely and usefully used under the numerous circumstances calling for their employment.—I am, &c.,

JOHN GAMGEE.

1, Great Winchester Street Buildings, E.C.,
February 3, 1871.

THE SEWAGE QUESTION.

To the Editor of the Chemical News.

SIR,—I have not replied to the letter which appeared in the CHEMICAL NEWS from Professor Corfield, because there really is nothing in it for me to reply to. He certainly points out some "mistakes" I have fallen into, but he has also kindly saved me the trouble, by showing afterwards that the statements are in the main true.

In reply to my friend Mr. Hope I must disclaim any intention or desire to "draw" him, and, least of all, into an admission that any thing he had printed in a scientific paper *could* be absurd. As, however, he has made this admission I am bound to say that I never thought he could have been *quite* serious in the *reductio ad absurdum* alluded to. When, however, Mr. Hope says that he has never seen the paper in which my "assertions" about irrigation were made, I must remind him that the paragraph referred to is extracted from my letter to the *Journal of the Society of Arts* (vol. xviii., p. 338). He answered that letter and had also then "the pleasure in contradicting them." For I never said they were not *contradicted*; what I said was that they were not *disproved*. I say so still. Either the distinguished advocate of sewage irrigation must have answered that letter without seeing it, or his memory is not so ever green as his connection with this subject would lead us to expect.

I need not trouble your readers with the question in dispute, as by referring to the *Journal of the Society of Arts*, as quoted above, anyone interested can read Mr. Hope's paper, my letters, and his answer.

Under exceptionally favourable circumstances, irrigation will, no doubt, be a source of profit, and, I am willing to admit that it is yet in its infancy, and that many mistakes have been made in ignorance; but as the universal remedy it is out of the question. Mr. Hope's farm at Romford is, perhaps, the only one where the conditions are thoroughly understood, and he deserves the success which all will wish him; but picture a farm in the west of Scotland of 120,000 acres under the Glasgow sewage during the past three months frost! Nevertheless the British Association Committee look upon it as the only general solution of the sewage difficulty. They are determined to view the question only through a water medium, and a rather muddy one, to thoroughly investigate no other method, and to shun all contact with any professors of opposite views.—I am, &c.,

EDWARD C. C. STANFORD, F.C.S.

Edinbarnet, Dumbartonshire.
February 1st, 1871.

MISCELLANEOUS.

Beet-Root Sugar in California.—The *News Letter* says:—"No one article in all the notices of the California Beet-Sugar Company begins to do the affair justice. We publish a few facts to correct the bungling misstatements made in the dailies during the past week. Two hundred and fifty barrels of A-1 sugar stands credited to shipment No. 1, with many more ready at mill to send over, and beets enough on hand to make two thousand barrels first-class sugar, besides second-class, syrups, &c. The mill, when running to its full capacity, will work 50 tons of beets per day: they are now running through about 40 tons every twenty-four hours. They have one hundred head of cattle under cover to fatten on the pulp. The managers met with no difficulties in reaching the result they have, the parties engaged in the affair knowing their business. They owe no one, and, so far as we can learn, there is no stock for sale, except at a premium."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 19, 1870.

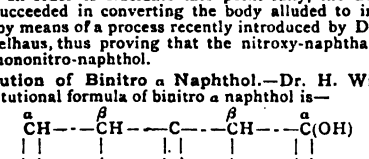
This number contains the following original papers and essays:—

Mononitro α Naphthol.—L. Darmstaedter and R. Nathan.—The introduction to this paper contains a brief review of the labours of Dr. Dusart on a substance obtained by him by the long-continued action of lime and caustic potassa upon nitro-naphthaline, named nitroxy-naphthalinic acid, described in the *Comptes Rendus*, vol. lii., p. 1183. The authors further state that the reason why they repeated the experiments of Dr. Dusart was that, in their opinion, the nitroxy-naphthalinic acid is nothing else than mononitro-naphthol, an opinion which is confirmed by the fact that the formula assigned by Dr. Dusart to the body just named—viz., $C_{20}H_7(NO_4)O,HO$, if written according to the present fashion—

$$C_{10}H_8NO_3\,OH$$
$$C_{10}H_6NO_3$$

differs only by one atom of hydrogen from the formula of mononitro-naphthol. In order to elucidate this point fully, the authors have tried and succeeded in converting the body alluded to into binitro-naphthol, by means of a process recently introduced by Drs. Wallach and Wichelhaus, thus proving that the nitroxy-naphthalinic acid is simply a mononitro-naphthol.

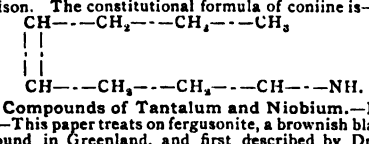
Constitution of Binitro α Naphthol.—Dr. H. Wichelhaus.—The constitutional formula of binitro α naphthol is—



First Synthesis of a Vegetable Alkaloid.—H. Schiff.—The author states that he has succeeded in the synthetical manufacture of coniine, the well-known alkaloid present in the *Conium maculatum*. The author obtained the alkaloid alluded to by the distillation of dibutyraldine, from which the alkaloid is generated according to the formula—

$$\underbrace{C_8H_{17}NO}_{\text{Dibutyraldine.}} = H_2O + \underbrace{C_8H_{13}N}_{\text{Coniine.}}$$

The artificially-obtained coniine, like that produced by the plant, is a violent poison. The constitutional formula of coniine is—



Native Compounds of Tantalum and Niobium.—Dr. C. Rammelsberg.—This paper treats on fergusonite, a brownish black-coloured mineral found in Greenland, and first described by Dr. Haidinger (*Pogg. Ann.*, vol. v., p. 166). This mineral was formerly taken to be yttrotantalite, and specimens thereof have been analysed several times, since this was first done in Berzelius's laboratory by Dr. Hartwall in 1828. The specific gravity of this mineral has been found different by different authors, varying from 4·89 to 5·838. A somewhat similar mineral, which has been named tyrite, and also bragite, has been found in Norway. The percentage composition of the Greenland mineral, according to Dr. Weber's analysis, is—Nb_2O_5, 44·84; ZrO_2, 6·93; SnO_2, 0·35; YO, 38·61; CeO, 3·05; FeO, 1·33; UO, 0·35. Fergusonite from Ytterby (Norway), analysed by the author of this paper, gave—sp. gr., 5·56; composition, in 100 parts—Ta_2O_5, 8·73; Nb_2O_5, 40·16; SnO_2, WO_3, 0·91; YO, 30·45; CeO and (La,Di)O, 7·80; FeO, 4·09; UO, 1·98; CaO, 3·40; H_2O. Tyrite, in 100 parts—Nb_2O_5, 45·0; Al_2O_3, 1·05; YO, 30·0; CeO, 5·74; (La,Di)O, 3·51; FeO, 1·48; UO, 6·52; CaO, 2·36; H_2O, 4·88.

Law of Avogadro.—J. Thomsen.

Preparation of Chlorine from Hydrochloric Acid.—J. Thomsen.—This paper contains some remarks and observations on Mr. H. Deacon's paper on a new method of the manufacture of chlorine. M. Thomsen begins by stating that his acquaintance with the paper published by Mr. Deacon is only derived from the abstract published in the *Chemisches Centralblatt* (No. 46, p. 723, 1870), and the remarks made only bear upon some purely scientific matters—viz., the calorific value and quantum which is called into play in the reaction described by Mr. Deacon.

Contribution to our Knowledge of the Conjugate Sulphur Acids.—C. W. Blomstrand.—This lengthy essay is, on account of the large number of complex formulæ it contains, not suited for useful abstraction.

Chemical Researches of the Berries of Berberis vulgaris (Barberries) and on the Presence of Acetic Acid therein, according to Dr. Hermbstädt's View.—E. Lenssen.—The result of the author's analysis is that the berries alluded to contain, in 100 parts—Glucose, 3·57; free acid, 6·62; vegetable albumen, 0·51; soluble pectine substances, 1·37; ash, 0·96 (total of matter soluble in water, 13·035); seeds, 8·04; shells and cellulose, 2·56; pectose, 1·69; ash in the matter insoluble in water, 0·37 (total matter insoluble in water, 12·290); water, 74·675;—grand total, 100·0. No acetic acid was found, while the acid alluded to was recognised as malic acid.

Observations on the Products of the Splitting-Up of Albuminous Compounds.—W. Knopp.—This paper contains an account of a series of experiments made by the author with the view of ascertaining the nature of the compounds which are obtained by the action of mixtures of chloroform and sulphuric acid, as well as sulpho-vinic acid, upon dry albumen. The author's experiments on this subject are not as yet quite complete.

Under the title of Correspondence, this number contains the condensed reports of three meetings of the Chemical Society at Zürich (Switzerland). We notice therefrom the following subjects:—

Desoxalic Acid.—H. Brunner.—The author describes the preparation of this acid, the formula of which is $C_6H_8O_9$; that is to say—

$$\underbrace{C_4H_6O_8}_{\text{Uvic acid.}} + \underbrace{C_2H_2O_3}_{\text{Glyoxylic acid.}}$$

The desoxalates of ammonium, barium, lead, and silver are described; while by far the largest portion of this essay is devoted to an exhaustive discussion, illustrated by lengthy formulæ, on the constitution and mode of origin of desoxalic acid.

Preliminary Notice on Sulphuretted Aniline.—V. Merz and W. Weith.—This paper treats on thionaline, $C_{12}H_{12}N_2S$, and several compounds thereof.

Lactic Acid Anhydride.—Dr. Wislicenus.—The author states that, when lactic acid is kept at the ordinary temperature of the air for a length of time in a vacuum, or even simply in a dry atmosphere, it is gradually converted into the so-called lactic anhydride.

Sitzungsberichte der Königlich Bayerischen Akademie der Wissenschaften zu München, vol. ii., No. 3, 1870.

This number contains the following original papers relating to chemistry and collateral sciences:—

New Locality where Monazite (Turnerite) Occurs.—Dr. G vom Rath.—The author states that, while inspecting the mineralogica collection of M. Handtmann, at Coblentz, the owner called his attention to a small crystal, partly imbedded in another mineral, which crystal, on testing it goniometrically, turned out to be the mineral known as monazite, or turnerite, and found near the locality, well known to tourists—the Laachersee (a deep lake, filled with very deep blue-coloured, nasty tasted water, which never freezes, situated in the neighbourhood of the Rhine, and being, in all likelihood, the crater of an extinct volcano filled with water). The contents of the author's paper on the above-named subject are entirely devoted to the crystallographical description of the rather rare mineral alluded to.

Experiments on the Germination of Seeds.—Dr. Vogel.—This memoir contains the detailed account of a series of experiments made by the author with the view of ascertaining the effect which various substances (as, for instance, aniline, amorphous phosphorus, dilute solution of permanganate of potassa, sulphate of copper, dilute acetic acid, dilute hydrocyanic acid, arsenious acid, illuminating gas, naphthaline, and other substances) have upon the germination of vegetable seeds. Among the substances which thoroughly impede, and even destroy, the power of germination, the author mentions dilute (0·21 per cent) acetic acid and phenylic acid (1 drop to 50 c.c.). It appears that otherwise the germination is not much affected by very dilute aqueous solutions of most of the substances above quoted.

Humate of Ammonia.—Dr. Vogel.—This paper is a treatise on the action of the salt alluded to, as regards its capability of dissolving silica and carrying it into the vegetable material of the plants during their growth.

Synthesis of Substituted Guanidines.—Dr. Erlenmeyer.—The contents of this paper do not agree with the title, since we read here a detailed crystallographical description of a platinum double salt of methyl-uramine.

Acids which are Formed during the Oxidation of the Butyl-Alcohol of Fermentation.—Dr. Erlenmeyer.

Valerianic Acids of Different Origin.—Dr. Erlenmeyer.—Since the author sent these papers to the editor of the *Berichte der Deutschen Chemischen Gesellschaft zu Berlin*, we have given an abstract of their contents already (see CHEMICAL NEWS, vol. 23, p. 22).

Physical Geography of the Elevated Portions of Asia.—H. von Schlagintweit-Sakülünski.—An interesting and extensive monograph on this important subject.

Journal für Gasbeleuchtung, December, 1870.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Supply of Water to Towns.—E. Grahn.—This lengthy memoir is a portion of a lecture given by the author before a meeting of water-works engineers, held at Hamburg last May, and contains, apart from matters strictly relating to the engineering part of water supply, a very excellent account of the origin of water in nature of its various functions in the three kingdoms of nature, and on the requisite qualities of water intended for domestic use.

Description of a Regulator Intended to Keep Up a Constant Temperature when Gas is Used for Heating Purposes in Chemical Laboratories.—T. Schlœsing.—This paper is illustrated by several woodcuts absolutely required for the proper understanding of the contents.

Water Supply of the Town of Kassel.—M. Pfaffen.—The detailed description of the works, area, and mode of supply, as well as of the natural resources whence it is derived.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin (double number), September and October, 1870.

This number does not contain any papers relating to chemistry or allied sciences.

NOTES AND QUERIES.

Gas Analysis.—Is there any recent book published abroad upon gas analysis?

Composition of Borneite.—Can any correspondent oblige me with the composition of the mineral known as borneite.—STIBIUM.

Separation of Gold and Silver.—Mr. Henry Pizey, the assayer, several years ago treated his chloride of silver with chlorine, to extract the small amount of gold, evaporated the filtrate down, and added protosulphate of iron. Is this process now carried out at all systematically? It seemed to me a very pretty operation.—PER MARE PER TERRAM.

Chemical Agriculture.—I would be much obliged if any of your numerous readers could inform me of a good work on chemical agriculture, and also of one on the manufacture and production of sugar, especially West Indian.—J. T.

Coating Cisterns.—(Reply to R. Binns.)—A mixture of slaked lime (dry) and a solution, moderately strong, of silicate of soda, forms an extremely hard and very watertight cement, but you will find it rather expensive, and you had better apply good hydraulic cement, or, perhaps, better yet, coat the cistern with coal-tar asphalte.

Sulphur Springs.—Can any of your numerous readers give any information respecting sulphur springs, the quantity of sulphuretted hydrogen present in any of these, the affections such waters are recommended for, and, generally speaking, the ailments for which sulphuretted hydrogen, either gaseous or dissolved, is considered to be beneficial?—T. H.

Protochloride of Antimony.—(Reply to "Amateur Chemist.")—There exist only a terchloride and pentachloride of antimony; the former may be prepared, as stated in Watts's "Dictionary of Chemistry," in various ways, among which are the following:—Passing a current of dry chlorine gas over antimony in excess; dissolving the tersulphide of antimony (black sulphide) in hydrochloric acid; or, also, by distilling a mixture of 3 parts of antimony in powder with 8 parts of corrosive sublimate. The compound here alluded to is a preparation kept in chemists' shops, and known vulgarly as butter of antimony.

Atomic Weights of Carbon and Oxygen.—The following are the percentages of carbon:—In acetic anhydride, 46·87; butyric anhydride, 60·67; benzoic anhydride, 74·05. If the molecules of these bodies are represented by the formulæ $C_4H_6O_3$, $C_8H_{14}O_3$, and $C_{14}H_{10}O_3$, respectively, and the atomic weight of hydrogen be assumed as 1, determine the atomic weights of carbon and oxygen by means of the method of least squares. Will some chemist kindly indicate the nature of the method, and its application in the present instance, or name some book in which the explanation may be found, and oblige—A STUDENT.

Soldering Iron and Steel.—(Reply to "George G.")—There are several soldering fluids in use; among these we quote—"A solution of phosphoric acid in alcohol at 80 per cent; the parts to be soldered are moistened with this solution, either by dipping in or with a hair brush. Another solution is that of the double chloride of zinc and ammonium, to be made by dissolving equal parts, by weight, of zinc and sal-ammoniac in strong hydrochloric acid, and evaporation to dryness at a gentle heat; the saline residue is afterwards dissolved in water, so as to make a strong solution. It is obvious that, after soldering, the metal has to be carefully cleaned, so as to remove any excess of adhering soldering salt solution, because both the liquids here alluded to would, if left on the iron or steel, cause it to rust.

MEETINGS FOR THE WEEK.

MONDAY, 13th.—Medical, 8.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology. (Educational Course.)
—— Royal Geographical, 8.30.
TUESDAY, 14th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
—— Photographic, 8. Anniversary.
WEDNESDAY, 15th.—Society of Arts, 8.
—— Meteorological, 7.
—— London Institution, 7. Conversazione. Mr. W. H. Perkin, F.R.S., Sec.C.S., "On Alizarine and other Colouring Matters."
THURSDAY, 16th.—Royal, 8.30.
—— Royal Society Club, 6.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
FRIDAY, 17th.—Royal Institution, 8. J. N. Douglass, Esq., "On the Wolf-Rock Lighthouse."
—— Geological, 1. Anniversary.
SATURDAY, 18th.—Royal Institution, 3. Prof. Jowett, "On Socrates."

TO CORRESPONDENTS.

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T. Morgan.—1. The report of the Deputy-Master of the Mint can be obtained at Hansard's, Great Queen Street, Lincoln's-Inn Fields. 2. You will probably find the paper in the *Philosophical Transactions of the Royal Society.*

Vox.—Consult "Traité des Arts Céramiques," par A. Brongniart; or "Chefs-Dœuvres of the Industrial Arts," by Philippe Burty, published by Chapman and Hall.

Marshall Hall.—Received with thanks.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 586.

ON A MODE OF DISTINGUISHING THE DEPOSIT OBTAINED BY REINSCH'S PROCESS FROM SALTS OF MERCURY.

By JAMES St. CLAIR GRAY, M.B., C.M.,
Assistant to the Professor of Medical Jurisprudence, Glasgow University.

As the deposits obtained on copper-foil by Reinsch's process are possessed of no distinctive characters by which that produced by one metal can be distinguished from that produced by another, it is necessary to have recourse to additional modes of investigation in order to determine to which of the four metals so precipitable the deposit is due; thus, two of these, arsenic and mercury, yield sublimates—the one crystalline, the other consisting of metallic globules—when the coated copper slips, thoroughly dried, are heated to redness in a dry test-tube, and by this property are distinguished from antimony and bismuth; again, two, arsenic and antimony, form with hydrogen, as pointed out by Marsh, gaseous compounds possessed of certain peculiar properties by which they are distinguished alike from mercury and bismuth and from each other. But these, as well as the other differentiating processes, require a very considerable degree of care, neatness, and dexterity of manipulation, when the quantity of the metal present in a large quantity of organic matter is very minute, as it often is in medico-legal investigations; and it has frequently occurred to me that a greater degree of simplicity might yet be attained,

The following is for mercury a test of even greater delicacy than that afforded by sublimation from the coated copper foil, dried, of metallic globules, and is possessed also of the advantage that the result can be seen by the unaided vision while its application is extremely simple. It is founded on the great affinity which exists between mercury and gold.

The following is the best and most simple mode of procedure. One of the copper slips, coated in the ordinary manner by Reinsch's process, is first washed in pure distilled water and then thoroughly dried; when thus prepared it is rubbed with a flattened bead of pure gold, or, should this not be at hand, a flat signet ring will suffice. The result, if the coating be mercurial, is that a portion of the mercury, whose affinity for gold is greater than for copper, is transferred from the copper to the gold, appearing on its surface as a clear, white, shining, metallic crust, this being more conspicuous the more highly coloured the surrounding gold is. This stain is at once removed by pure stong nitric acid. This is of itself perfectly conclusive of the presence of mercury in the metallic coating or deposit on the copper, and is equally applicable should there exist in that deposit a combination of mercury with any or all of the other three metals which yield by Reinsch's process a metallic deposit on copper-foil.

15, Newton Terrace, Glasgow,
February 10, 1871.

OBSERVATIONS ON THE MANUFACTURE OF VERMILLION.

By M. ALSBERG, Ph.D.

IN the process of manufacturing vermillion by Martin's method (agitation of quicksilver, sulphur, and alkaline sulphuret), two different stages can be easily distinguished; first, the combination of mercury and sulphur to the black sulphide; and secondly, the conversion of this amorphous black modification into the crystalline red. The chemical combination, as well as the crystallisation, is accompanied by the evolution of considerable heat, which may become so great, especially during the latter stage, and when working in closed vessels, as to give rise to dangerous explosions.

The crystallisation, a consequence of the solubility of the black sulphide in the alkaline sulphuret, and its gradual precipitation in the red form, only takes place when the mass is warm. If it be kept cold it requires a great length of time, often weeks, and even months, until the crystals are formed. If, on the contrary, the crystallisation has once set in (this is indicated by the black mass turning brown), it is generally finished within twenty-four hours. In the case of the slow crystallisation, there are sometimes crystals obtained, which, in colour and form, greatly resemble the native ore; the same crystals are occasionally formed when the solution of alkaline sulphuret containing sulphide of mercury is concentrated. Professor J. P. Cooke, jun., of Cambridge, who examined some crystals of that kind, says:—"They were rhombohedra, approaching a cube, and have the peculiar form of macling, which is so characteristic. They are, doubtless, the primitive rhombohedra observed on the native crystals, R on R 92° 36'. The faces are striated parallel to the basal diagonal of the rhomb face, and the crystals are terminated by the plane of a more obtuse rhombohedron of the same order."

The solubility of the sulphide of mercury in the alkaline sulphurets is considerable, especially when the fluids are concentrated, and then even in the presence of polysulphurets. This solution cannot be diluted without the sulphide of mercury being precipitated in the black modification, but the precipitation may be prevented by the addition of a small quantity of caustic alkali.

Evidently this is the reason that Weber says, that sulphide of mercury will dissolve in alkaline sulphurets only in the presence of free alkali, whereas solutions of the alkaline sulphurets, containing so much sulphur as to look deep red or brown, will readily dissolve enough of the sulphide to give, on dilutions, a considerable black precipitate. The precipitate does not always form immediately, but invariably makes its appearance after a short lapse of time.

The solubility* of the sulphide of mercury constitutes the chief source of loss in the manufacture of vermillion, and, on an average, amounts to from five to eight per cent of the mercury taken.

In spite of all precautions, it will sometimes happen that the mercury "flours," and, as it seems, every minute globule is coated with a thin layer of sulphide. This coat not only prevents the conversion of the metal into the sulphide, but even its solution in nitric acid. If concentrated nitric acid be used, the whole of the sulphide and metal is dissolved, whereas dilute nitric acid has no effect at all. Concentrated hydrochloric acid, especially when boiling, will readily decompose the sulphide.

As is well known, no vermillion will withstand the action of the light; it turns dark and gradually black again. Whether this change is due to the decomposition of the sulphide into the sub-sulphide and free sulphur, or simply to the conversion of the crystalline into the amorphous modification, is doubtful; but it is certain that any impurities increase this tendency, especially the presence of free mercury, which seems to indicate that a decomposition does take place, though always only on the surface. Even the passing of steam or the evaporation of a drop of water over some vermillion will often rapidly effect this change of colour. Of course, the value of the vermillion greatly depends on the stability of colour, and therein the different articles of commerce vary greatly.

* It is generally stated that sulphide of ammonium does not dissolve sulphide of mercury, but, judging from the fact that, according to Liebig and Gautier Bouchard, sulphide of ammonium effects the crystallisation of the black sulphide, it seems probable that this statement is not quite correct.

Some will retain their brightness for several years, while others may be seen to change after a few weeks. If, perhaps, the vermillion obtained by sublimation is a little more stable than that manufactured by the wet process, it certainly, with respect to brightness and fire, does not sustain comparison with the latter; therefore, the latter constantly gains more ground. The different shades, from a deep red almost to an almost light orange, are simply a consequence of the size of the crystals; the larger the crystals, the deeper the colour, and *vice versa*, so that large crystals resemble, in their cochineal colour, the native cinnabar.

Until a few years ago, all the vermillion used in the United States was imported mostly from Europe, and some from China, but now our own manufacturers have defeated foreign competition, when taking into account the high price of labour, &c. The protection by duty is very small, but not only have our manufacturers successfully competed with Europe, but they have even reduced the price considerably, thereby again increasing the use of their product. It may be safe to say, that the annual production in America amounts to 500,000 lbs., and may, before long, reach 1,000,000 lbs. The precarious condition of the California mercury mines may place our manufacturers in a dangerous position, compelling them to obtain their supply of mercury from Spain, at a greatly increased cost. Already, within the last six months, the price of mercury has risen fully 35 per cent, and, as the mercury trade is a monopoly, it may go higher still.—*American Chemist.*

ON GLUCOSE.

By Prof. CHARLES A. JOY.

In the year 1811, Kirchhoff, a celebrated German chemist, discovered that it was possible to convert starch by means of sulphuric acid into sugar. Great expectations were founded upon the announcement of the discovery, as, in consequence of continental wars and the English blockade, sugar had become a very dear article, and it was at first thought that an ample supply could be obtained in this way; but everybody was destined to be grievously disappointed as soon as the subject was more thoroughly investigated, and it was found that the sugar thus produced was of a different character from that to be obtained from the cane and beet. Still, the discovery of Kirchhoff was of great importance, and has led to many practical applications. It was soon found that glucose or grape sugar could be made in several ways, and that it was always the product of the germination of starch grains, and sometimes occurred already formed in nature.

It is probable that both cane and grape sugar are formed from the starch contained in the cellular tissues of the plant, cane sugar being formed first, and then grape sugar, if acids be present. Acidulous fruits contain only grape sugar, whereas cane sugar occurs in those that are free from stronger acids. The chief natural sources of the grape sugar are in the sap of the grape vine, in plums, cherries, figs, honey, in the liver and in diabetic urine; but it would not be economical to prepare it from any of these sources.

One of the latest methods for the preparation of grape sugar is the one proposed by Maubré, and is as follows:—the mixture of dilute sulphuric acid and starch meal is boiled under pressure of six atmospheres. The necessary boilers are similar to those used for high-pressure engines, and are lined with lead and provided in the interior with a perforated lead tube for the passage of steam. The boiler is further furnished with safety valve, stop-cocks, thermometers, &c. In the process of manufacture, 56 pounds of sulphuric acid of 66° B. are diluted with 5600 pounds water, and heated to 212° F. A mixture of the same amount of acid and water is made in a separate wooden vessel, the heat of which is raised to 86° F. Into the second mixture 2240 pounds of starch meal are well stirred and heated to 100° F. This is gradually added to the first mixture, and after heating with open valves for a few minutes to 212° F., the stop-cocks are all closed and the heat raised to 320° F., and continued until all of the starch is converted into sugar, which requires from two to four hours.

The contents of the boiler are then run into a wooden tank, and 168 pounds of pure chalk or carbonate of lime, previously stirred up with 500 pounds of water, are gradually added to neutralise the acid; the gypsum is caught on a filter and the filtrate evaporated to 20° B., and afterward clarified by blood and bone-black and again filtered. In this way the product is obtained pure and free from bitter and empyreumatic taste, and is well suited for any of the purposes to which grape sugar is adapted.

Another way is to convert the starch into sugar by means of malt. For this purpose 10 to 12 pounds of barley malt are well stirred with 400 pounds of water, and to this are added 100 pounds of starch, and the whole is heated to 158° F., and kept at that temperature for several hours under constant agitation. At 158° F. the starch becomes pasty, the grains burst, and at first there are no signs of sugar, but in a quarter of an hour the liquid becomes more fluid and begins to have a sweetish taste. Great care must be observed to retain the heat at the same temperature, not to have it either higher or lower than above indicated; and to insure this several thermometers ought to be put in different parts of the apparatus. After six hours the liquor can be filtered and clarified, and evaporated to a syrup. The sugar prepared in this way always retains the taste of malt, and is only adapted to use in breweries, where this property will not prove deleterious.

Grape sugar, or glucose, can be prepared in open vessels by allowing a mixture of starch and water to flow gradually at a temperature of 130° F. into a vat containing water acidulated with one per cent of sulphuric acid. By keeping it at a boiling point the starch is at once altered, without producing mucilage. The amount of starch taken is usually about one-half the weight of water employed. After all of the starch is added, boil for an hour and decant. The sulphuric acid is neutralised by carbonate of lime as before, and the liquid evaporated to the specific gravity of 1·28, and set aside to crystallise. The molasses is allowed to drain off, and the sugar is dried at a gentle heat in a current of dry air.

In the United States, especially in the West, it is more economical to make grape sugar from corn. There are several large establishments where this business is now extensively prosecuted. The corn is steeped in weak soda-lye to separate the husk and soften the gluten. It is then ground wet and run through revolving sieves, by which the husks and gluten are separated. The starch flows through long ways and troughs, in which are slats against which the solid particles lodge, and thus separate from the water. The wash water is run into a large cistern, where it can be fermented into weak vinegar. The starch is put wet into a mash tub and treated with one per cent sulphuric acid in sufficient water, for three to eight hours. Where it is intended to make sugar, the whole of the starch is converted; but if syrup is sought, then some part of dextrine is left unaltered. The acid liquor is neutralised with chalk as before, and evaporated in vacuum pans, and, after the separation of the gypsum, is run into barrels and allowed to crystallise. For syrup a certain percentage of the dextrine is left in the liquid unconverted, which helps to keep it from cystallising, and in the manufacture of syrup special care must be observed to neutralise all of the acid. The sugar is sometimes cast into blocks six inches square and dried on plaster plates, in a current of dry air, as hot air would be apt to discolour it. It has been found that glucose can be made

from cellulose as well as from starch, but the process is too expensive for practice; it is, however, interesting from a scientific point of view, and ought to be mentioned in this connection.

Two parts of clean linen shreds are gradually added to three parts of sulphuric acid, and they are allowed to stand twenty-four hours. The whole is then largely diluted, and the sulphuric acid neutralised by carbonate of lime or carbonate of baryta. In a similar manner any other kind of cellular tissue, as cotton, wood-shavings, paper, &c., can be converted into grape sugar.

It is a singular fact that, although we can prepare grape sugar from cane by the action of acids, no way is at present known by which glucose can be re-converted into sucrose. It would be a discovery of great importance if we could make cane sugar from glucose, as in that event common sugar could be prepared from a great variety of refuse matters, and would be largely reduced in price.

There was a time when much grape sugar was manufactured in England clandestinely, for the purpose of adulterating muscovado sugar, but this illegitimate business was destroyed as soon as the tariff on sugar was reduced. The price of cane sugar must be very high before manufacturers can afford to make grape sugar for its adulteration.

The starch of potatoes can be converted into glucose by digesting for a few hours with parings of the potato. This operation is largely practised by German farmers in the preparation of food for fattening hogs. The starch is rendered more digestible in this way, and from the glucose some of the larger proprietors manufacture alcohol for which they obtain a high price.

An excellent article of starch sugar can be prepared from Indian corn, which will yield alcohol one-eighth cheaper and quite as pure as that from cane sugar. As by a recent decision of the courts, the manufacturers of vinegar from this source are not distillers within the meaning of the tax levy, the business is not hampered by licences, inspections, or stamp duties, and has thus a great advantage.

In some parts of Europe large quantities of grape sugar are used to add to wine, but in America it is not so much the wine growers as the brewers who make such an extensive use of it as to give rise to its regular importation. This can hardly be justified excepting in times when the price of barley is very high.

We find in the *Zymotechnic News*, of St. Louis, an interesting article on the uses of starch sugar in the manufacture of beer, from which we quote the following paragraphs:—

"Barley contains on an average 57 per cent of starch and cognate substances. These pass into the wort, partly as sugar, partly in the shape of dextrine (gum). The relative proportions of these ingredients vary in accordance with the method of brewing, but experience teaches that, on an average, one bushel of barley yields about 12 pounds of sugar and 15 pounds of dextrine. A portion of the latter substance is further transformed into sugar during fermentation, so that a bushel of barley represents, on an average, 16 pounds of sugar and eleven pounds of dextrine (gum).

"Both dextrine (gum) and sugar are equally essential to the brewing process. The latter furnishes the alcohol, without which no beverage can be called spirituous; while the former constitutes almost the entire extractive matter, or body of the beer, which is one of the chief distinguishing features between beer and wine. Now it is true that all (commercial) starch sugar contains a certain amount of dextrine—the more the poorer the quality; but this portion would be insufficient in case a good article were used, while, in the contrary case, it would be paid for at an extravagant rate.

"Imported potato sugar of good quality, containing some 15 per cent of dextrine (gum), costs about 12 cents per pound at New York. Maize sugar of equal purity can be furnished at 8 cents per pound. Twenty pounds of either article, costing respectively 2·40 dols. and 1·60 dols., would yield 16 pounds of fermentable sugar and three pounds of dextrine (gum), while a bushel of barley will yield not only 16 pounds of sugar, but eleven pounds of dextrine or gum besides. Thus, starch sugar can be added to beer wort only in small quantities, unless when it is desired to impart a vinous character to the beer. When the latter object is not in view the best substitute for barley will always be found in maize or some other cheap grain.

"Not so in the manufacture of wine. For this purpose, good starch sugar, containing not exceeding 15 per cent of dextrine, is decidedly preferable to cane sugar. A pound of the latter, of the quality suitable for wine manufacture, costs at least 15 cents; whereas, as just stated, good starch sugar from maize can be sold at 8 cents. Now, as 5 lbs. of starch sugar are equivalent to 4 lbs. of cane sugar as regards their yield of alcohol, the balance is altogether in favour of maize sugar, to wit:—

	Cents.
4 lbs. cane sugar at 15 cents	60
5 lbs. grape sugar at 8 cents	40

"The 15 per cent of dextrine (gum) contained in the maize sugar will (according to the usual proportion of sugar added to must) increase the amount of 'extract' in wine only by a few per cent, and will tend to give it the 'mouthly' taste (body) which in meagre wines, already fermented, is sought to be produced by the addition of glycerine.

"Enormous quantities of cane sugar are already being consumed in the wine manufacture in this country; so that even as a consideration of national economy it is highly important to supply in maize sugar a partial substitute for imported cane sugar."

In France there is a use for grape sugar arising from the fact that the sugar manufacturers do not prepare molasses ready for the market as they do in this country. The crude molasses is bought up by second parties and the grape sugar is used very largely by them to extend it and give it body. An alkaline solution of grape sugar is converted by heat into a dark brown body, called melassic acid. This acid has a powerful affinity for oxygen, and reduces the CuO to Cu_2O. Some of the tests for grape sugar are founded upon this reaction. One of them, known as Fehling's test, is prepared as follows:—A standard copper solution is made from 1 oz. crystallised sulphate of copper, 3 ozs. cream of tartar, 1½ ozs. pure carbonate of potash, 14 or 16 ozs. of a solution of caustic soda (sp. gr. 1·12) and water until the solution measures 15,160 water grains; 200 measured grains of this solution contain a quantity of copper that would be reduced by 1 grain of sugar, each atom of sugar reducing 10 atoms of the black oxide of copper to the state of suboxide. Cane sugar is converted into grape by boiling with weak sulphuric acid, and it can then be easily tested by the standard solution. It sometimes becomes necessary to test for sugar in diabetic urine. This is accomplished in various ways. One of them, called Trommers's test, is as follows:—Add caustic potash, and filter if necessary; then dilute solution of sulphate of copper in small quantities; the precipitate that first forms dissolves on stirring, and the solution becomes azure-blue, but after standing, a fawn-coloured precipitate of suboxide of copper will be formed. The conditions and precautions to be observed are fully given in medical works and need not be repeated here. The property of grape sugar to reduce metallic salts is made use of for the preparation of silver mirrors. Add to the nitrate of silver a few drops of ammonia and then some grape sugar, and the metal will be precipitated.

Chloride of silver can also be reduced by grape sugar, and this method affords a way for reclaiming photographic wastes, and of preparing pure metallic silver. Take 14 parts of well washed and still moist chloride of

silver, 24 parts of caustic soda, sp. gr. 1·333, 11¼ parts ammonia, sp. gr. 0·925; to this add, with constant agitation in a flask, 7½ parts pure honey, or 9½ parts grape sugar syrup, and let the mixture stand in a warm place until sulphuretted hydrogen affords no sign of silver. Decant and wash out all traces of chlorine. The reduced silver can then be dried and melted in a crucible.

Platinum black, finely divided metallic platinum, can be obtained from the chloride by adding carbonate of soda in excess, and, after adding grape sugar, heating the solution for ten minutes. The precipitate can be collected in a filter and then well washed and dried.

Grape sugar crystallises in warty, cauliflower concretions composed of hard transparent cubes. It is less soluble in water than cane sugar, but more soluble in alcohol. Two and a half parts of glucose are required to produce the same sweetening effect as one part of cane sugar. Sulphuric acid does not decompose it, but forms a definite acid with it, called sulpho-saccharic acid. It forms a double salt with common salt.

$$NaCl,2(C_{12}H_{12}O_{12})+2aq.$$

It also forms definite but unstable combinations with the alkaline bases.

From the foregoing it will be apparent that grape sugar can be easily and cheaply prepared, and that it is capable of many important uses in the arts, if it could be manufactured in adequate quantity and at a reasonable rate.—*Journ. App. Chem.*

ON THE

ESTIMATION OF PHOSPHORUS IN CRUDE PIG-IRON, IN STEEL, AND IN MALLEABLE IRON.

By F. KESSLER.

THE methods at present in use for the separation of phosphorus from iron by the moist way are based either upon the formation in an alkaline fluid of an insoluble combination of one of the two bodies, leaving the other dissolved, or on precipitating the phosphorus in an acid solution; the molybdic acid method belongs to the latter class, and this method, as improved by various authors, is well suited for the requirements of the industrial estimation of phosphorus in iron, although it is troublesome and tedious. This last-named defect induced me to commence experiments with the view to find out whether it would not be possible to find a method of removing iron, and the other metals it is accompanied with, from an acid solution, and to estimate the phosphorus afterwards.

Starting from the well-known reactions of the two salts, commonly known as yellow and red prussiates, containing iron in the two conditions of ferrosum and ferricum, experiments were instituted in this direction, and, after some preliminary investigation, I found that I should be limited to the use of the following reaction:—

$$FeCl_2 + K_4FeCy_6 = 2KCl + K_2Fe_2Cy_6.$$

If it be supposed that 1 per cent of phosphorus in iron is indicated by the production of 1 decigrm. of pyrophosphate of magnesium, and, since that salt contains 27·93 per cent of phosphorus, it is evident that we have to take a quantity of 2·793 grms. of crude iron to experiment upon. As, however, a filtration from a bulky precipitate is required, it is preferable to double the quantity of metal and weigh off 5·6 grms. This quantity of metal, after solution in acid, requires no less than 42 grms. of crystallised ferrocyanide of potassium, and the ensuing precipitate will weigh at least 34 grms. exclusive of chemically combined water.

This fact sufficiently indicates the necessity of a correction in reference to the bulk of this precipitate, and since I could not find any published account on the specific bulk and gravity of this precipitate, I made a series of experiments, taking care to adjust the proportions according to the plan devised and indicated above. I dissolved 11 grms. of soft iron wire in hydrochloric acid, and 84 grms. of ferrocyanide of potassium in water, taking care to dilute each of these solutions to 500 c.c.; the specific gravity of the iron solution was equal to 1·055, while that of the ferrocyanide solution was found to be equal to 1·093. 250 c.c. of each solution having been taken were mixed in a flask holding 500 c.c., and the joint bulk found to be equal to 505 c.c. the liquid was filtered, care being taken *not* to wet the filter previously; the specific gravity of the filtrate was found equal to 1·033. From this the bulk of the liquid is calculated according to the following equation:—

$$250\,(1{\cdot}055 + 1{\cdot}093) - 34 = 503 \text{ grms.}$$

and the bulk of the precipitate—

$$505 - \frac{503}{1{\cdot}033} = 18 \text{ c.c.}$$

It hence follows that, in order to take 250 c.c. filtrate as the half of the total, the liquid mixed with the precipitate has to be previously diluted to 518 c.c. But this quantity may be varied from 517·5 to 518·5 according to the variable quantity of pure metal present in 5·6 grms. of crude iron as compared with the quantity of pure iron present in the 5·5 grms. of iron-wire solution just alluded to. Since I employed in my experiments the large crystals of the ferrocyanide of potassium as met with in commerce, it became necessary to ascertain the quantity of phosphates or other impurities present in the salt, and the amount thereof in the quantity constantly to be used, so as to eliminate this source of error altogether, or to take it into account; this was done in the following manner:—A measured quantity of chloride of iron, containing 5·58 grms. of iron and absolutely free from any phosphorus, was mixed with the ferrocyanide solution and further treated (the full description of my method I will give presently), for phosphorus by the pyrophosphate of magnesium method; instead of obtaining, however, that salt, I got a small quantity of a yellow-coloured flocculent substance, which, including the ash of the filter, left, after ignition, a quantity of 1 milligrm. and, consequently, instead of taking the quantity of the filter ash at 0·0005 grm. I took it during my experiments at 0·0010 grm.

Take 56 decigrms. of crude iron, previously suitably broken up—for cast-iron the substance should be passed through a sieve the meshes of which are 0·5 m.m. apart—put the metal into a porcelain crucible 11 centims. diameter at the top, and a depth of 13 centims., and provided with a handle and spout (a so-called casserole) and add to the metal 60 c.c. nitric acid, sp. gr. 1·2, taking care to cover the vessel with a large sized watch-glass. After the first violent action has subsided, the crucible is gently heated so as to cause the slow evaporation of the nitric acid; when, after the lapse of about one and a half hours, the materials contained in the crucible begin to get rather thick, the vessel is uncovered, and heated more strongly over an argand burner, care being taken to prevent spirting by the moving about of the crucible. As soon as the mass is dry, the handle of the crucible is fastened in a suitable manner so as to admit of the crucible and contents being heated to very bright redness (if a muffle is at hand it answers the purpose best); after the cooling of the vessel its contents are transferred to a platinum crucible. After the ignition of the materials in the platinum crucible to oxidise the carbon they are again transferred to the porcelain crucible and therein treated at a gentle heat with 35 c.c. of hydrochloric acid, sp. gr. equal 1·19, until the whole of the substance in the vessel, excepting some perfectly colourless silica, is dissolved. The method of dissolving the metal here described does away with the separate treatment of any phosphorus-containing residue in the case of nitrohydrochloric acid being employed for the solution of

the metal. The acid solution obtained, as just mentioned, is poured, without any previous filtration, into a flask of at least 518 c.c. capacity, and diluted to about 200 c.c. A caoutchouc plug is next placed into the neck of the flask, care being taken to have the plug perforated with two holes, through one of which a glass rod is passed, so as to admit of being used as a valve, while through the other hole, a glass tube is passed, which is let down through the neck of the flask just until it reaches the wider part of the flask; the tube is, by a suitable means, put into communication with a self-acting sulphuretted hydrogen apparatus. The sulphuretted hydrogen gas having been turned on, the operator opens the valve by removing the glass rod from the plug and shakes the flask, taking care not to spill any liquid; this operation is continued until the reduction of the iron and precipitation of copper, or any other metals precipitable by sulphuretted hydrogen, become apparent, as shown by the running together of the sulphur to small globules and the brownish colour imparted to the liquid. This method of reduction is more rapidly and readily effected than the reduction by means of a sulphide.

The next operation consists in pouring into the flask 200 c.c. of an aqueous solution of ferrocyanide of potassium, prepared so as to contain 210 grms. of the crystallised salt in 1 litre. The contents of the flask are next diluted to 518 c.c., and the liquid filtered through ordinary dry filtering-paper, folded as usual—the diameter of the filter being 27 centims., the funnel to be covered with a glass plate. The filter is at once filled to the rim, so as to moisten the paper thoroughly. The turbid liquid which at first passes through (about 20—30 c.c.) are separately collected, and after the turbidity subsides the filtrate is collected into the 250 c.c. flask.

The filtration is relatively the most tedious portion of the entire process, since it takes nearly an hour and a half. When a quantity of 250 c.c. of the liquid has been collected in the flask, its contents are poured into a beaker-glass, into which are previously poured 10 c.c. of a solution of sulphate of magnesium, of a strength of 200 grms. to the litre, and strong liquid ammonia in excess. For the proper separation of the ammonio-phosphate of magnesium, the liquid is left standing at least over night. The operator will observe that the salt just alluded to is always covered with a greyish coloured flocculent substance; but, without troubling about the nature of this impurity, which is completely removed by a subsequent operation, the manipulator brings the ammonio-phosphate of magnesium (as it does not adhere to the sides and bottom of the beaker-glass), and the body just alluded to, on a small filter, washes it somewhat with liquid ammonia of 0·98 sp. gr., and next dissolves the salt adhering to the sides of the beaker, and also that contained on the filter in nitric acid of 1·035 sp. gr. There will remain on the filter an insoluble and blue-coloured cyanogen compound. To the nitric acid sclution, liquid ammonia in excess is added, and, after the complete separation of the pure ammonio-phosphate of magnesium, it is collected on a small filter, washed with liquid ammonia of 0·98 sp. gr., until, on testing, no more chlorine is detected, it is next dried and ignited.

After deduction of the weight of the ash of the filter and the impurity above alluded to (in the author's mode of operation, amounting to 0·0010 grm.), every decigramme of ignited pyrophosphate of magnesium amounts to 1 per cent, or, more correctly, to 0·9975 per cent, of phosphorus.

The author and inventor of this method states that a lengthy series of comparative experiments made by him have proved that the method just described is in every respect correct, and suitable for all practical purposes, and applicable to the proper estimation of phosphorus in crude pig-iron, steel, and malleable iron. He considers it to be preferable to the molybdic acid method.—*Journal für Praktische Chemie.*

THE PRODUCTION OF IODINE AND BROMINE.

By W. H. CHANDLER.

To Scheele is the world indebted for the first intimation of the elementary existence of fluorine and chlorine, he having in 1771 referred the action of sulphuric acid upon fluor-spar to the freeing of a distinct acid from the mineral, though whether fluorine has, even up to the present day, been isolated, is a matter of great doubt. In 1774 the same chemist isolated chlorine. In 1811 Courtois separated iodine from the waste liquor from the manufacture of soda-ash from seaweed, followed by the discovery of bromine in the bittern of sea-weed by Balard in 1826. The isolation of these four closely-allied elements from their compounds is thus included in a century, and the application of them to economical purposes, to any extent, was accomplished since the beginning of the present century. Their close relationship, their physical properties, and their chemical affinities, which are nearly in an inverse proportion to their chemical equivalents, induce one to the supposition that they are modifications of the same element.

The isolation of chlorine, bromine, and iodine from their compounds with the alkalies, is accomplished with equal facility. But the abundant store of the former in the enormous deposits of common salt throughout the world and in solution in the ocean and inland seas, forms a striking contrast to the rarity of the two latter halogens. In combination with silver, bromine and iodine are found in some rare ores in Mexico and South America. Chatin claims to have detected iodine in rain water, though in very minute quantities, and even in the atmosphere. In sea-water traces of it have been uniformly detected, though not in quantities sufficient for quantitative estimation. Bromine exists in slightly larger quantities, and, associated with iodine and chlorine, is found in the ocean and inland seas, the mineral and saline springs, and salt deposits, throughout the world.

According to Von Bibra, the amount of bromine in the Atlantic Ocean, in one United States gallon, is 24 grains; in the Dead Sea, examined by Herapath, 121·5 grains; in the dried residue of the Mediterranean, 1·15 per cent; in the mineral spring of Kreusnach, Ure found 10·8 grains; in Kissingen water, determined by Kastner, 0·44 grains; at Tenbury, in Worcestershire, examined by Dr. Ure, as high as 12·5 grains; and at Arnstadt, according to Hartung, 13·6 grains. Iodine occurs in far less quantities, from mere traces to 2·2 grains per gallon, this latter quantity being found in the iodine spring at Halle.

In the United States both bromine and iodine have been detected in the various saline and mineral springs. Iodine was first detected in America, in the Saratoga Spring waters, by Drs. Usher and Steel, in 1830, and bromine in the same waters by Dr. A. A. Hayes, and in the salines of Onondaga by Professor B. Silliman, in the same year. The quantity of bromine in the spring waters of Saratoga county, determined by Professor Chandler, reaches 3·63 grains per gallon in the water of the Artesian wells, the largest amount of iodine found being 0·2 grain; but in America, as in Europe, it is in the salines that the quantity of these substances becomes of economical importance, and in a brine of the Saginaw Valley, Dr. Chilton found 7·65 grains of bromine; at Tarentum, Pa., 6 grains bromine and 4 grains iodine were reported by Stieren; in the salina brine analysed by Professor Goessman, however, only 1·36 grains of bromine per gallon are reported.

Besides these various sources, iodine has been detected in the soda deposits of Peru, in the ashes of the Spanish barilla plants. Cod-liver oil is said to owe some of its medicinal properties to a trace of iodine. Though the distribution of bromine and iodine is thus very general, yet owing to their existence in such comparative minute quantities, the sources of our commercial supply are much more restricted.

Up to the beginning of this century the alkalies of commerce were derived from the ashes of plants, and the burning of sea-weeds was an important industry, especially in Great Britain and Ireland.

The amount of ashes of sea-weed, the so-called kelp, reached its maximum production in 1800, when 20,000 tons were collected. To produce this, 400,000 tons of wet weed were burned. From this time, owing to the removal of the import duty and to the introduction of the manufacture of soda-ash from common salt, the trade declined. But the discovery of iodine in the mother-liquors of kelp salts somewhat revived the manufacture—and it is to this source alone that the total supply of iodine in commerce is due. The high price stimulated the business, and in America, in a few places in New England, iodine factories were established. These latter, however, were soon abandoned, the weed upon the coast being of poor quality. The process of separating the iodine is exceedingly simple, being nearly analogous to that for the isolation of chlorine. The ashes are leached with water, and the various crystallisable salts of potash and soda are separated by concentration. Carbonates, sulphates, and chlorides of potash and soda are thus removed, leaving in solution sulphite, hyposulphite, and some carbonate of soda, together with the iodides and bromides. By the addition of sulphuric acid the first three salts are decomposed, and the sulphate produced is removed by crystallisation. The concentrated mother-liquor is acidulated with sulphuric acid, and after the addition of binoxide of manganese, the iodine and bromine distilled off. The reaction may be represented thus:—

$$NaI + MnO_2 + 2(HO,SO_3) = NaO,SO_3 + MnO,SO_3 + I.$$

The bromine of commerce was derived mostly from salines until the salt mines of Stassfurt were opened; the Schoenebeck salt springs, near Madgeburg, producing the greater part of the supply for Germany. The method of manufacture is similar to that followed in the separation of iodine.

Upon opening the mines of Stassfurt, bromine was found in the mother-liquors in considerable quantities, and at present the principal part of the European product is derived from this source. As high as 300 grains per gallon has been obtained from these mother-liquors. Although but two or three of the manufactories at this place have economised this substance, the price of bromine has greatly decreased during the last five years. This decrease hae been hastened by the large production of bromine in the United States.

Although the amount of bromines in the Saratoga waters is considerable, yet the comparatively limited flow of water, and the large consumption of those waters for medicinal purposes, precludes the manufacture. But from the strong salines our supply is derived in large quantities. At Tarentum, Sligo, and Natrona, in Western Pennsylvania, Pomeroy, Ohio, and Kanawha, West Virginia, the manufacture of bromine has become of considerable importance. The production of 1870 will reach 125,000 pounds, a quantity probably in excess of the consumption. In 1867 the Stassfurt product of bromine was nearly 20,000 pounds.

The total product of iodine in Great Britain and France is about 200,000 pounds annually, and outside these two countries very little is produced. As the average product of iodine is about ten pounds to the ton of kelp, and it requires twenty tons of wet weed to produce one ton of kelp, this total product represents the burning of 400,000 tons of sea-weed. At the present price, the iodine produced is of more value than the alkaline salts, which were the original object of the industry.

As previously stated, iodine is not produced in the United States. Since its use was first established here the price has fallen from 16 dollars to 5 dollars per pound. At present, bromide is furnished for less than 1¼ dollars per pound.

The chief consumption of iodine and bromine is for medicinal purposes in the form of iodides and bromides of potash, soda, or ammonium. A small proportion is consumed in photography. Bromine has been proposed as a discharge in calico printing, and during the late American war was to some extent employed as a disinfectant. As yet but a small proportion of the bromine of the saline mother-liquors is economised, but should manufacturers turn their attention to this important substance, the consequent reduction in price will render its economical employment in other directions possible.—*American Chemist.*

NOTE ON THE ZIRCONS OF MUDGEE, NEW SOUTH WALES.

By Professor A. H. CHURCH, M.A.

I RECENTLY obtained a few rounded pebbles, each weighing about 2 grammes, for examination; they came from Mudgee, New South Wales. Although the specimens did not present the usual lustre of worn surfaces of zircon pebbles, yet their obviously high density, and the traces they retained of their pyramidal form, nearly sufficed to identify them with the zircon; this idea was amply confirmed by the results of experiment.

The Mudgee zircons present the exact tint known as hyacinthine; indeed, the true hyacinth or jacinth, about which such constant mistakes are made by jewellers, lapidaries, gem-collectors, and even mineralogists, is now an attainable luxury. The engraved gems and the cut stones commonly called jacinths (even by Dana—*vide* his "Mineralogy," 5th ed., p. 275) are invariably, so far as my experience goes, nothing but the hyacinthine garnet, a comparatively common stone possessed of far less interesting properties than the true hyacinth. The Mudgee zircons are rather dark; the colour is distributed somewhat irregularly in and upon many of the specimens. When cut, facetted, and polished, this Australian zircon, if not too deep in colour and too large in size, presents a rich soft red colour tinctured with orange-brown. I was fortunate enough to secure one pale-coloured specimen, which, now that it has been judiciously cut, has turned out a stone of surpassing brilliancy and beauty.

The density of one of the Mudgee stones was 4·704. After heating, it was found to have become quite colourless, although its density remained virtually unchanged, namely, 4·699. In these and most other particulars the Mudgee specimens resemble those of similar colour from Expailly, in Auvergne.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

February 2nd, 1871.

Professor WILLIAMSON, F.R.S., President, in the Chair.

Discussion on Professor Frankland's Paper "On the Development of Fungi in Potable Water."

THE PRESIDENT, having expressed the thanks of the Society for the interesting communication, asked whether the phosphoric acid present in the sugar had been taken into account?

Professor FRANKLAND thought that, through the crystallisation of the sugar, the phosphorus would have been excluded.

Dr. HEISCH was glad to hear that his statements had been confirmed by Dr. Frankland's experiments, but in two important points these were diametrically opposed to his own results. The first point was the statement that water which had been filtered through animal charcoal still retained organic germs. Now he (Dr. Heisch) has

been investigating, week after week for the last three years, large quantities of water which had passed through charcoal filters, and not on one single occasion had he found any fungoid growth in such water. The other point of divergence is, that whilst Dr. Frankland declares the cellular formations obtained from white of egg in a sugar solution to be very similar to the sewage fungi, he (Dr. Heisch) finds the two kinds of cells very easily to distinguish from one another. The sewage fungus is very small, perfectly spherical, excessively transparent, and mostly grouped in grape-like bunches. The development and decay of these cells is very often a rapid one; about six hours after the introduction of the sewage matter into the sugar solution the spherical cells appear, which, after six more hours, have grown into mycelia, and a short time after the whole vegetation has disappeared. But the special property which marks the whole growth of the sewage fungi is that it is accompanied by the emission of the odour of butyric acid. This circumstance is wanting in the development of organisms derived from white of egg; the cells, too, in the latter case, have a different look from the sewage fungi. Dr. Heisch then enumerated some pathological cases, which went to show that the noxious germs in potable waters are mostly contained in the same, and not derived from the atmosphere.

Dr. RUSSELL said, that soon after the reading of Mr. Heisch's paper, in June last, he had undertaken a series of experiments in the same direction, and he arrived at the same results. He also had investigated a sample of the Romford Farm effluent water by means of the sugar test, and met, like Dr. Frankland, with a negative result.

Mr. BELL remarked that the samples which Dr. Russell examined had, perhaps, been kept for some time, in which case they would have purified themselves by a process of natural decay. He procured seven samples from Dr. Frankland, four of which had been obtained in 1869; these when submitted to the sugar test did not become turbid, while three which had been taken in October and November last became turbid. When Dr. Heisch read his paper it occurred to him (Mr. Bell) that the investigation of the subject had not been exhausted. He had some doubt as to the cause of the turbidity, which is rarely produced in sugar solutions by fungoid development accompanied by the production of acid only. Shortly after Dr. Heisch read his paper, a gentleman brought a sample of water taken from a well in Drury Lane to the laboratory for examination. Mr. Lewin added some sugar to a portion of the water and, in about twelve hours, the sample became turbid, and when examined microscopically, was found to be alive with those little creatures which Mr. Bell had been in the habit of seeing in various vegetable extracts, and he at once inferred that these organisms caused the turbidity and not the fungoid development. He made various experiments with phosphates, and found that, when calcic phosphate is present, a large development of Bacteria is produced in solutions. He also made various experiments with water to which animal charcoal had been added, and with water passed through animal charcoal, and in every instance the water produced bacterian bodies on the addition of sugar. He further found that pure water into which ignited charcoal had been introduced might be kept a considerable length of time without developing any organisms on the addition of sugar, thus showing that the charcoal itself forms a suitable soil for organic germs.

Dr. VOELCKER confirmed the fact that sewage easily undergoes alteration. A jar of sewage left standing loosely covered for some months, lost almost all its ammonia, whilst its amount of nitric acid had increased. Referring to the insufficiency of charcoal for filtering purposes, Dr. Voelcker stated that iron sponge surpasses it very much in that respect. Water filtered through this medium could perfectly stand Mr. Heisch's test. Spongy iron is obtained by calcining with charcoal the residues from burnt copper pyrites.

Dr. THUDICHUM declared that a great deal more is talked about fungi than is really known, and that the whole fungus theory is a mere surmise and has no real standing ground.

Mr. WARINGTON explained that the purifying action of the spongy iron consisted probably in the removal of the phosphates in the water, since these would be retained by the hydrated ferric oxide wherewith the sponge is largely crusted. Mr. Warington further called attention to the fact that fresh animal charcoal gives up some phosphates to the percolating water, whereas charcoal that had for some time been in use does not, and he thought this may help to understand the difference in the respective results arrived at by Dr. Frankland and Dr. Heisch.

Dr. DUPRE asked whether Dr. Frankland had boiled the sugar solutions? Whenever he (Dr. Dupré) had done it, he obtained no fungoid vegetation.

Dr. FRANKLAND said in reply—

(To Dr. Dupré)—Usually they were not boiled, but in experiment No. 9 the sugar was burnt to caramel, the water previously treated with caustic soda and potassic permanganate, and all the salts added to it were heated to a considerably high temperature,—and in that experiment more splendid fungi were obtained than anywhere else.

(To Dr. Heisch)—The discrepancy in the observations as to the efficiency of charcoal seems to be explained by Mr. Warington's remark. As to the comparison of the two kind of cells, he did not consider them identical, but still rather similar to one another. Whether during the development of the sewage fungi the odour of butyric acid was perceptible or not, to this he had not paid attention.

(To Mr. Bell)—The samples of effluent water were taken into examination a day or two after their collection.

(To Dr. Voelcker)—The quick disappearance of the ammonia in sewage and sewage water had very frequently been noticed by himself.

(To Dr. Thudichum)—As to the fungus or germ theory of disease, he (Dr. Frankland) had nowise committed himself to it.

GLASGOW PHILOSOPHICAL SOCIETY.

(CHEMICAL SECTION).

A MEETING was held in the Society's rooms, Corporation Buildings, on Monday evening, the 30th ult., Alexander Whitelaw, Esq., in the chair.

Mr. JOHN SUTHERLAND read a note "*On the Pumping of Hot Liquids.*

Mr. E. C. C. STANFORD, F.C.S., referring to a paper read before the British Pharmaceutical Conference at Liverpool, exhibited a stuffed specimen of the fulmar (*Fulmarus glacialis*) from the Island of St. Kilda, and of the oil vomited by this bird.

In the parish of Harris, Inverness, nearly 200 miles fron Inverness, and about forty-five miles west of the nearest point in North Uist, 57° 50′ N. lat. and 8° 35′ W. long., is situated perhaps the most remarkable, certainly the loneliest, little village in Great Britain.

"St. Kilda's lonely isle" is seldom reached by strangers, and I therefore record briefly some impressions derived from a recent visit. There are several islands, one of which only, the south or main island, is inhabited.

Seen from North Uist on a very clear day, the main island has exactly the appearance of an enormous whale on the horizon, and the north islands look like a huge sea-fortress with a tower on each side.

The north island, or island of Boreray, with its surroundings is, perhaps, the boldest. We sighted this island in the early morning looming through a dense mist, and quite close to the vessel. As the mist suddenly cleared away, a startling scene presented itself. A perpendicular rock, some 1000 feet in height, sheer out of the Atlantic, towered above our heads. Its face, covered with lichens of every variety of colour, was gorgeously illuminated by the rising sun. It was flanked

by two enormous rocky pillars 800 to 900 feet in height, one of which is beyond the perpendicular. This rock is an extraordinary sight; it is perfectly white from sea-line to summit, being completely covered with the white eggs, droppings, and feathers of an innumerable family of Solan geese, which are said to keep this rock entirely to themselves. We astonished the winged inhabitants by a cannon-shot, but they repaid the astonishment with interest, for we were unprepared for the extraordinary effect of the myriads of wings which immediately hovered over and around us, and turned day into night.

St. Kilda proper lies about three miles south of Boreray. It may be described as a precipitous mountain ridge, which, in some parts falls sheer into the sea, with enormous precipices some 1500 feet high. It is three miles long and two miles in its extreme breadth. It lies 50¼ miles due west of Schillay Island in the Sound of Harris. The formation is marked in Nicholl's geological map as greenstone with syenite veins. On the south-east side the hill slopes down to a small open bay much exposed, and the landing is difficult. On this side of the hill the village is situated. About thirty houses, well built and better roofed than is usual in the West Highlands, are occupied by about seventy inhabitants. The population does not increase, the infant mortality is large, and said to be peculiar to the island.

It is somewhat remarkable that the inhabitants are not fishermen, but are all farmers and birdcatchers. Until quite recently none of the men knew how to fish. The staple food of the island is a bird called the fulmar, which forms the subject of this notice.

This bird is a species of petrel, the *Fulmarus glacialis*, or *Procellaria glacialis* of Linnæus, the Fulmar petrel of Buffon, belonging to the family of *Procellariæ*, order *Natatores*. At a distance the bird might be mistaken for a gull, which it resembles in size and colour; it is more nearly allied, however, to the albatross, which it resembles in its remarkable bill and its vomiting oil when attacked. The head, neck, and lower parts are pure white, the wings and back bluish-ash, and the bill bright yellow. The bill is stout and thick; the upper mandible considerably hooked at the tip, where it is also dilated and sulcated; the lower mandible is straight and slightly truncated. The nostrils are united in a single tube. A sharp claw on the legs takes the place of a hind toe. The flight of the bird is very beautiful, and it has a remarkably graceful movement of the head. The fulmar inhabits Polar regions, and, so far as I can ascertain, is unknown in any other of the outer Hebrides, and is found only on St. Kilda. It breeds enormously there in the rocks, laying a single large white egg, and the young are fed by the oily matter disgorged by the parents.

The strong bill enables them to extract oily matter, by perforating the skin of dead seals or whales.

In Newfoundland they feed largely on the codfish offal, and probably they are experienced fishers everywhere.

The method of catching these birds is peculiar to St. Kilda; the men may well call themselves birdcatchers, for assuredly there are none like them. The process seems simple enough, but the awful danger must be seen to be appreciated; indeed, the climbing propensities of these men would astonish any member of the Alpine Club.

Hanging on a rope (often made of horse-hair) the birdcatcher descends the fearful precipices, armed with a sort of fishing-rod, having a slip noose at the end. This he dextrously throws over the head of the bird, which is sitting on the ledge of the rock beneath him, and hauls him up. He then dips the bird's beak into a small leather bag suspended to his waist, and there the oil is vomited. The bird is then killed and eaten as food, the feathers and the oil forming the two articles of export. Beds made of the feathers are said never to harbour insects, but it is alleged also that they are difficult to keep dry.

The oil is a good deal mixed with a rougher sort from Solan geese, and realises a poor price as an ordinary rough fish-oil. The sample I exhibit is genuine. It is of a clear, dark, slightly reddish sherry-colour, and has a powerful aad peculiar odour—an odour of which the whole island and all the inhabitants smell. It is certainly a fish-oil, and it possesses nearly all the properties of cod-liver oil.

Its specific gravity is midway between cod-liver and sperm.

Fulmar oil, specific gravity	0·902
Cod-liver, light ,, ,, ...	0·924
,, brown ,, ,, ...	0·929
Sperm oil ,, ,, ...	0·875

It is soluble in ether. Cold alcohol dissolves less than 1 per cent, and hot alcohol 3 per cent.

Treated with a drop of oil of vitriol, it produces precisely the same coloured reactions as cod-liver oil, which, if the generally-received views be correct, would show it to be a liver-oil.

It contains a very faint trace of iodine.

Heated with oil of vitriol and excess of potash, it gives off a strong odour of oil of rue.

Saponified with soda, the soap retains the peculiar odour, and yields a tolerably fluid fatty acid on acidifying the solution.

I shall be glad if this short notice of fulmar oil will induce any one to experiment with it for medicinal purposes. I have no doubt a good deal might be obtained, and a good market would be a boon to that isolated people.

The specimen of fulmar exhibited is one of two that I had stuffed after keeping them alive for about a fortnight. It has suffered a little in appearance from its captivity.

Since the publication of this paper in the *Pharmaceutical Journal*, Mr. Norman McRaild, the factor of St. Kilda, writes me that the most of the birds are caught in August when young, and when they are very fat. Each bird throws up a small glassful of oil, perhaps about 1 oz., and 8000 to 9000 are killed every year, yielding about 50 gallons of oil. At one time the people lived entirely on the flesh of these birds. Now they make a good deal of a rougher oil from the salted bird. 675 gallons of this oil were sold in 1869 by the factor in Skye for smearing purposes, at 2s. 6d. a gallon. This is a lighter and thicker oil than the true vomit; but has the same chemical character.

Mr. P. L. Simmonds, the editor of the *Journal of Applied Science*, has sent me a specimen of Penguin oil from the Falkland Islands, in reference to which I quote an article in the *Journal of Applied Science*, for November, 1870, by B. Delfino.

The Slaughter of Penguins and Seals.—During the whole of August and beginning of September, large and countless flocks of penguins come from all directions to the Falkland Islands, and where they alight the ground is literally covered with them. This periodical migration is for purposes of reproduction. The people who make a business of killing these birds for their oil, proceed about this time in schooners capable of weathering the storms that are so common at this season. Besides a small crew, these schooners have on board a "copotar," with a gang of from twelve to fifteen men. Their only arm is a short stick. On the island to which they repair, they find a rough kind of furnace that has been used the previous year, and which seems to heat one or more iron boilers, each of which is capable of holding as much as 250 gallons of oil. These islands are leased from the Colonial Government for five years at a small rent, and every exporting house has several rookeries, which are respected by the rest. The penguin hunters are generally at their post before the arrival of their intended victims, and when these arrive and drop on the ground by millions, the men go among them and commit great havoc upon the tired birds, heaped together, whose wings are intended more as helps to swim than to fly. After the lapse of five or six hours of incessant slaughter, the "copotar" and his five

men generally have got enough of birds for one night's boiling. Each man immediately picks up a certain number of the dead birds and begins to skin them. This operation is done by making a cut in the belly, and, with a peculiar knack, the whole skin, with feathers and all, comes off the bird at one pull. I have seen one man, after five or six hours' work, present to the copotar about nine hundred penguins ready for the boiler. A certain quantity of fatty matter adheres to the skins, which are generally used to feed the fire. The furnace where the boiling-down operation is carried on is kept burning all the time the men reside in the islands, and serves beside to cook their food and protect them from the intense cold of these regions. The fat of eleven birds gives about one gallon of oil, and it is calculated that a gang of fourteen men, with a copotar, returns after a month and a half's campaign with a quantity of oil varying from twenty-five to thirty thousand gallons. With every flock of penguins, that is, with every three, four, or five thousand, there comes a bird larger and of a different plumage. The penguin's feathers are of a light ash colour, with brown spots, while those of this bird are white, with a yellow tuft on the head resembling a crown, and two rings made of yellow feathers, also on each side of the head, looking something like the ornament worn by ladies in their ears. The English call him the "king of the penguins," and he is seldom killed, perhaps owing to the fact of his being as remarkable for his leanness as the penguins are for their fat.

This oil, which appears to be a large article of commerce, is a dark brown oil, with the same general character as that from the fulmar.

It is remarkable that though these oils are obtained from birds, they have all the characters of fish oils, and all give the colour test with oil of vitriol.

I append comparative specific gravity and melting-points of the fatty acids from the soaps.

	Sp. gr.	Melting-point of fatty acids.
Fulmar oil, true vomit	0·902	70° F.
,, from flesh of bird ..	0·910	82° F.
Penguin oil	0·922	102° F.
Cod-liver oil, light	0·924	—
,, ,, brown	0·929	—
Sperm oil	0·875	—

The colour test has always been held to be due to the presence of cholic acid or other biliary matters; so that either these birds must feed partly on these substances or the test is illusory.

An interesting article appeared in the *Journal of Applied Science* (October, 1870) on the mutton bird of Australasia (*Procellaria obscura*), which appears to be closely allied to the fulmar in its character and uses.

The author also exhibited specimens of white and pink Tyree marble, the analyses of which have been already published in the CHEMICAL NEWS. As there was some doubt thrown on his former statement that the dark green crystals imbedded in the pink matrix consisted of hornblende, these had been since submitted to analysis, with the following result:—

Silica	60·00
Lime	11·64
Magnesia	3·32
Peroxide of iron	3·42
Alumina	22·18
	100·56

with a slight trace of manganese. This analysis corresponds with some already published of aluminous hornblende.

The author also gave a verbal communication of some experiments that were in progress, to show in a complete form the actual loss of nitrogen when fresh meat is mixed with various kinds of charcoal; in continuation of a former paper on "*The Retention of Organic Nitrogen by Charcoal*," already published in the CHEMICAL NEWS. The experiments had been some months in progress, and the results were promised, when completed, in a future paper.

NOTICES OF BOOKS.

Handbuch der Angewandten, Pharmaceutisch-und Technisch Chemischen Analyse als Anleitung zur Prüfung Chemischer Arzneimittel und zur Visitation der Apotheken, wie als Wegweiser zur Untersuchung und Beurtheilung von der Pharmacie, den Künsten, den Gewerben und der Landwirthschaft angehörenden chemischen Präparaten und Fabrikaten. Unter Berücksichtigung der älteren und neueren Pharmakopöen Deutschlands, Oesterreichs, der Schweiz, Englands, Frenckreichs, und Russlands, wie der Ergebnisse der neuesten Forschungen im Gebiete der Technischen Chemie, in vierter. Auflage neu bearbeitet von ADOLF DUFLOS, Dr. der Medicin und der Philosophie, Königlichem Geheimen Regierungsrathe und Professor. Mit erläuternden Abbildungen nach R. Brodengeyers, Zeichnungen in Holzschnitt ausgeführt. Ein Ergänzungs-Band zu den ver schiedenen Ausgaben von des Verfassers Werk, Chemisches Apothekerbuch. Ferdinand Hirt, Königliche Universitäts und Verlags-Buchhandlung. Breslau, 1871.

Handbook of Applied Pharmaceutical and Technical Chemical Analysis; intended as well for a Guide in the Testing of those substances (Chemical Compounds) employed in Medicine as for a Guide to the Inspection of Chemists' Shops and the Testing of Materials employed in Arts, Manufactures, Agriculture, and collateral branches of industry. Written with reference to the older, as well as the more recent Pharmacopœæ of Germany, Austria, Switzerland, Great Britain, France, and Russia, and including also the most recent researches in the domain of Technical Chemistry. By Dr. ADOLF DUFLOS. Breslau: F. Hirt. 1871.

UNDER the above title, quoted in full, we have received for review a copy of a work which deserves the attention of all who are interested in the study and practice of chemistry. The author is a Frenchman by birth and education, and for the last forty years he has been well and deservedly known for his scientific attainments all over Germany, and wherever the German language is read and understood.

The work before us is a handbook of chemical analysis, more especially applied to the pursuits of the pharmaceutist, but almost equally so to the requirements of the technologist, agricultural chemist, and manufacturing chemist; while its author intends it to be considered as a supplement to a larger work, entitled "Chemisches-Apothekerbuch"—a comprehensive work on chemistry, wherein such preparations as are employed in pharmacy are treated more fully than is the case in ordinary treatises on chemistry. As regards the work under review, this edition is the fourth, but the work is intrinsically a new one, having been re-written and enlarged, so as to embrace subjects beyond the scope of pharmacy; the result being a book unique of its kind, and got up with minute care and with the embodiment of all the latest researches published up to the time of going to press.

It is impossible to give even a faint idea of the amount of carefully digested and clearly explained matter condensed in some 400 pages, and embracing, as may be gathered from the title, all the chemical preparations used in pharmacy, embodying the older and more recent pharmacopœæ of Germany, Austria, Switzerland, England ("British Pharmacopœia"), France, and Russia. Not only are the commoner preparations described, as regards their characters and the proper modes of testing their purity, but also the rarer substances. In order to give our readers some idea of the manner of treatment, we take as instance—*Acetum (vinegar)*: Characters of that liquid; quantitative tests for the determination of its strength—viz., the quantity or real acetic acid it contains; tests for the detection and estimation of alcohol and aldehyde present in the vinegar; qualitative tests for the presence of sulphuric

acid; quantitative estimation of that acid; tests for hydrochloric acid; tests for nitric acid; tests for metals. Among the rarer substances, we quote as examples—*Amygdalinum* (the names are given in Latin and German), $C_{40}H_{27}NO_{22}=457$: Characters of this body; tests for its purity, and especially for the detection therein of salicine. Under the heading—*Anilinum*—

$$NC_{12}H_7, \text{ or } NC_{12}\left.\begin{matrix}H_2\\H_5\end{matrix}\right\}=93:$$

The author treats first of the pure substance, describing at length its properties and the tests for its purity; he next treats of the salts, and then of aniline oil (commercial aniline), the aniline colours, and the best means and methods of testing these for arsenic. *Liquor Hollandicus; æthylinum chloratum, chloride of ethylen*, $C_4H_4,Cl_2=99$: Description of characteristic properties and means of testing for its purity. *Carbonium bichloratum sulfurosum*, CCl_2,SO_2; or *trichlormethylium chloratum bisulfurosum* (bisulphited terchlorinated methylic chloride)—

$$C_2Cl_3,Cl+2SO_2=218:$$

Description of characteristic properties. *Natrum choleinicum* (a mixture of glycocholate and taurocholate of soda): Description of characteristic properties.

We could, without difficulty, add hundreds of examples, naming among them a large number of substances which are common articles of commerce—such as petroleum, phosgen, solar oil, petroleum ether, petroleum benzine, paraffin—not particularly belonging to the domain of pharmacy and manufacturing chemistry. In the appendix, we meet first with a concise description of the manures of commerce, and the modes of testing them qualitatively and quantitatively; and secondly, the author has added a brief, but excellent, chapter on reagents and on qualitative testing. The work is copiously illustrated with excellent wood engravings, contains an exhaustive index in Latin and German (each separate), is illustrated with a portrait of the author, and is well printed on good paper. The names of the paper maker, the printer, and the xylographic artist, are specially mentioned on the reverse side of the title-page.

OBITUARY.

JAMES SHERIDAN MUSPRATT.

We regret to have to record the death of Professor James Sheridan Muspratt, M.D., F.R.S.E., &c., which took place at West Derby, Liverpool, on the 3rd inst. The deceased was born at Dublin on the 8th of March, 1821, and was the son of the well-known founder of extensive chemical works established near Liverpool. The Professor was a pupil of the late Mr. Graham, first at Anderson's University, Glasgow, and afterwards in London, and also studied under Baron von Liebig at Giessen. The deceased was the founder of a College of Chemistry at Liverpool, and was well and widely known in the scientific world by a variety of scientific publications bearing upon chemistry in its widest sense; among the works edited by him, that styled "Chemistry, Theoretical, Practical, and Analytical, as Applied to Arts and Manufactures" is most widely known; but the English work, although containing undoubtedly a very great deal of valuable information, has been immensely improved upon by Dr. F. Stohmann, who has edited a German translation of this work, which is in every respect superior to the original, although divested of the large number of steel plate engravings representing the portraits of a series of scientific men. The deceased was a member of a large number of scientific societies, and many of his later researches have been published in the Chemical News.

CORRESPONDENCE.

DR. FRANKLAND'S PAPER ON THE DEVELOPMENT OF FUNGI IN POTABLE WATER.

To the Editor of the Chemical News.

Sir,—I have read with the greatest possible interest your account of Professor Frankland's paper on this subject, as his ingenious experiments really seem to have brought us a long way nearer to a comprehension of "the physical basis of life" than we were even so recently as when Professor Huxley delivered his opening address to the British Association at Liverpool. A firm believer in the existence of a "physical basis" of infection, I would suggest a third rendering of the dictum of the German philosopher which he quotes, namely, "*Ohne Phosphor gar kein Ansteckung.*" This certainly seems to me exceedingly *probable* at all events, and perhaps "Heisch's test" may supply that test for infection, or even for the germs of non-infectious disease, which ordinary methods of chemical analysis do not afford; and Dr. Frankland may now have got an unfailing test for the dangerousness or harmlessness of any given "previous sewage contamination."

I ought to add that with regard to the general impurity of the sample of effluent water which Dr. Frankland took at my Romford farm in November last, I found, after the sample was taken, but before leaving the farm, as I think I mentioned to Mr. Smith, the Secretary of the Rivers' Commission, that, owing to some new drains having been only just filled in and some others being altered, some sewage was escaping into the outfall without passing as usual through 5 or 6 feet of *consolidated* soil. Yet I hope that further researches will show that even this imperfectly purified water was not dangerous.—I am, &c.,

W. Hope.

Parsloes, Feb. 12, 1871.

MISCELLANEOUS.

London International Exhibition, 1871.—The buildings in which this will be held are now finished, and ready to receive the exhibits. They will accommodate altogether 50,000 persons. The object of the Commissioners in holding the Exhibition may be summed up as follows:—They propose, in the first place, to make an International Exhibition a permanent institution of the country, giving to industrial art the same opportunity that is afforded to fine art by the annual exhibitions of the Royal Academy. In the second place, they produce the area over which the exhibition shall spread itself, by reducing the various industries into groups, and taking certain of these each year, bring the entire industry of the country under review every seven or eight years, fine art being a standing division of the programme. And, in the third place, to restrict the conditions under which exhibits have hitherto been received, by making all articles undergo a preliminary sifting, through appointed committees of selection, thus excluding all works that do not possess sufficient artistic merit to warrant their exhibition, and by the further exclusion of mere masses of natural products. The manufactures exhibited this year will be woollens and pottery, in addition to fine art of every description. H.R.H. the Prince of Wales is the President of Her Majesty's Commissioners for the Exhibition; Messrs. Spiers and Pond are to be the refreshment contractors; Messrs. Chaplin and Horne the carriers; and Her Majesty's Commissioners have entered into arrangements for the printing and publication of the official catalogues by Messrs. J. M. Johnson and Sons, of Castle Street, Holborn, London.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Journal für Praktische Chemie, Nos. 19 and 20 (double number), 1870.

This number contains the following original papers and essays:—

Some Derivatives from Oxysulpho-Benzide.—J. Annaheim.—(Preliminary notice.)—After briefly referring to some of his former researches, the author states that, by treating oxysulpho-benzide with iodide of methyl and iodide of amyl, he has obtained the following compounds:—

$$\underbrace{\left.\begin{matrix}C_6H_4OCH_3\\C_6H_4OCH_3\end{matrix}\right\}SO_2}_{\text{Methyl-oxysulpho-benzide.}} \quad \text{and} \quad \underbrace{\left.\begin{matrix}C_6H_4OC_5H_{11}\\C_6H_4OC_5H_{11}\end{matrix}\right\}SO_2}_{\text{Amyl-oxysulpho-benzide.}}$$

Chemical Constitution of Diglycolic Acid and some Compounds allied therewith.—Dr. H. Kolbe.—This essay is not well suited for useful abstraction, since it would require the reproduction of a large number of lengthy and complex formulæ.

Composition of the Oil contained in Kernels of the Avoira Elais.—Dr. A. C. Oudemans, jun.—This excellent essay contains a detailed account of the author's researches on that kind of orange-coloured oil known in the trade as palm oil. The oil alluded to consists chiefly of the glycerides of laurinic, palmitinic, stearic, and oleic acids, mixed with small quantities of tricaprine, tricapryline, and tricaproine. In 100 parts the substance contains, in round numbers—Tri-oleine, 27·0; tri-stearine, 31·7; tri-laurine, 41·3.

Benzol-Disulpho Acid Chloride, and on Thioresorcine.—Dr. O. Pazschke.—(Preliminary notice.)—The chloride of the benzol-disulpho acid is readily obtained by the action of pentachloride of phosphorus upon dry benzol-disulphate of soda. The resulting body is solid; crystalline; soluble in ether; fuses at 62°; when acted upon by tin and hydrochloric acid, a violent reaction takes place, and a new substance is obtained which fuses at 27°, boils at 243°, and possesses a penetrating odour somewhat akin to benzol-sulpho-hydrate. On analysis, this body was found to consist of $C_6H_6S_2$; this compound should be viewed as resorcine, the O of which has been replaced by S. The author continues his researches, desirous to obtain compounds isomeric with thioresorcine.

Periodides of the Alkaloids.—Dr. S. M. Jörgensen.—This monograph, of which only the first portion is here published, cannot be abstracted so as to give even the least idea of the immense amount of labour and scientific ingenuity the author has brought to bear upon this subject.

New Chloride of Platinum.—S. A. Norton.—(Preliminary notice.)—When 1 molecule of chloride of platinum ($PtCl_4$) in aqueous solution is mixed with 2 molecules of nitrate of silver, the result is the formation of salt, $PtCl_2+AgCl$ (described in *Comptes Rendus*, vol. lxiii., p. 553). The yellowish coloured filtrate from this precipitate does not contain any silver nor nitric acid, but simply chlorine and platinum; the body obtained on evaporation crystallises, does not deliquesce, and its concentrated aqueous solution is not precipitated by ammonia. The author thinks that this compound may probably be—

$$PtO_2.4HCl + aq. \quad \text{or} \quad (PtCl_2)O.2HCl + aq.$$

American Journal of Pharmacy, February, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Decomposition of Acetate of Morphia in Solution.—J. M. Maisch.—After referring briefly to some well-known spontaneous decompositions observed to take place in the aqueous solutions, not simply of alkaloids (as, for instance, sulphates of quinine and morphia), but also in some neutral solutions of certain inorganic salts, among which are neutral acetate, and succinate of ammonia (first observed by M. Horst, see *Archiv. der Pharm.*, 1823), the author proceeds to say that Dr. W. T. Taylor, of Philadelphia, U.S., informed him that, while always keeping in stock, for external use, a solution of acetate of morphia, he (Dr. Taylor) had repeatedly observed the separation in the liquid of some few crystals which, on examination, proved to be pure morphia, entirely free from acetic or other acid, and yielding the usual characteristic reactions. At the same time the liquid had deposited a considerable quantity of a brown matter, while the fluid was of a pale brownish colour. The fluid was neutral to test-paper; became reddish coloured with chloride of iron, which tint disappeared on the addition of hydrochloric acid. The liquid, after having been acidulated with nitric acid, was rendered turbid by the addition of iodohydrargyrate of potassium; evidently some minute portion of acetate of morphia remained in solution. The author observes that the acetic acid contained in ordinary vinegar becomes decomposed, and that the changes noticed in the solution of acetate of morphia are, perhaps, of a similar nature; while the question is raised concerning the utility or disadvantage of the addition of acetic acid to some pharmaceutical preparations.

Precipitation of Quinine by Iodide of Potassium from Acid Solutions.—J. M. Maisch.—A prescription was ordered for preparation to consist mainly of 15 grains of sulphate of quinine, 1 drachm of iodide of potassium, and the same quantity of tincture of chloride of iron (of course according to the strength prescribed in the United States Pharmacopœia). The alkaloid salt was dissolved in the tincture of iron, and the iodide of potassium in water. The solutions having been mixed, a brown precipitate was at once formed, whereupon a fresh portion of sulphate of quinine was dissolved in water with the aid of a little sulphuric acid; the iodide of potassium was next added, and after this was dissolved the tincture of iron, when the same result was observed. The purity of the iodide of potassium having been duly ascertained, a series of experiments were instituted with reference to a statement made by Dr. Righini (*Journ. de Chim. Méd.*, vol. xiii., No. 116), to the effect that bisulphate of quinine produces, with iodide of potassium, a red pulverulent precipitate. The examination of the precipitate obtained in compounding the above prescription, after washing with water, exhibits, when dry, a brown-coloured powder, emitting a slight odour of iodine, which is slowly evolved. When the precipitate is treated with ammonia, it changes to a dull cinnabar-red; dissolved in acids, it yields a copious precipitate with iodo-hydrargyrate of potassium; heated upon platinum-foil, it is decomposed, leaving, first a bulky charcoal, which, on being burned off with some difficulty, leaves no residue; so that the precipitate only contains iodine in addition to the elements of quinine.

Emulsion of Almonds.—H. P. Reynolds.—The following prescription may be of extensive utility, and for that reason we depart for this time from our general rule of not entering upon the direct territory of pharmacy. Take sweet almonds (blanched), sugar, and glycerine ("C. P."), of each 1 ounce; powdered gum arabic, 1 drachm; water, 2 ounces. Rub to a uniform paste, strain through muslin, and evaporate, by a heat not exceeding 150° F., to the consistence of a fresh solid extract; preserve in wide-mouthed bottles, of size convenient for use; may be flavoured to suit taste. The author prefers orange-flower water and oil of almonds. When an emulsion of almonds is prescribed, as is now often the case, as a vehicle for chloral hydrate, it is readily prepared as follows:—Take concentrated emulsion, 2 drams; water, sufficient to make 1 ounce of mixture; mix thoroughly. The above emulsion is preserved, or rather condensed, milk of almonds, and may be useful for dietetic and culinary purposes—as, for instance, to prepare readily orgeade. The syrop d'orgeade does not, as is well known, keep for any length of time without fermenting, and thereby spoiling.

Morphiometric Process for the Pharmacopœia.—W. Procter, jun.—An excellent essay on the assaying of opium to determine its morphia strength.

On Glycyrrhizin.—J. M. Hirsch.—A memoir answering the question as to the easiest method of isolating glycyrrhizin, and on its property and mode of action of masking bitterness.

Artificial Preparation of Mannite.—J. M. Hirsch.—This paper contains the account of some experiments on the preparation of mannite by artificial means, more especially for the production of that material to replace the drug known as manna, which has become very scarce. These experiments, not being quite successful, are to be followed by others.

Sitzungsberichte der Königlich Bayerischen Akademie der Wissenschaften zu München, vol. ii., No. 4, 1870.

This number does not contain any papers or memoirs relating to chemical or allied sciences, but contains a lithographic reproduction, accompanied by a learned essay, on the oldest map known to be in existence—viz., a map of the Nubian gold mines, the facsimile being reproduced from the specimen belonging to the collection of Egyptian antiquities in the Museum at Turin.

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt, No. 3, 1870.

This number contains three lengthy essays relating particularly to the geognosy and paleontology of the Austro-Hungarian empire, while a fourth essay is devoted to the geology of the Eastern portion of European Turkey. As usual, these essays are illustrated by magnificently-executed lithographs, and, as regards the last-named essay, by a large-sized coloured geological map.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin November, 1870.

This number does not contain any papers relating to chemistry or collateral sciences.

NOTES AND QUERIES.

Gas Analysis.—Bunsen's work on this subject is equal to every requirement.

Colouring of Confectionery.—Would you kindly inform the undersigned which is the best innocuous yellow colouring matter for confectionery purposes? Also as to the toxicological properties of carmine of cochineal, indigo, and ultramarine?—INNOCUUS.

Mineral Oil.—Can you or any of your readers say the reason why pale mineral lubricating oil (stored in iron tanks), should go darker coloured the longer it is kept?—B. S.

Artificial Mineral Waters.—Will you kindly recommend me a book containing the best and latest information on the manufacture of artificial mineral waters, either in English or French.—S. C.

Benzole.—The trade reports quote for quality "30 per cent,"—this must refer to English make. Is it 30 per cent distillate to 100° C.? if so, what relative value has Scotch benzole distilling 45—50 per cent to 100°, and 90 per cent to 120° C.? It appears English benzole is richest in colouring matter.—CARBON.

Sulphur Springs.—T. H. will find full details in Pereira's "Materia Medica," vol i., pp. 298, 299; Longmans, 1849. I will copy the particulars for him if he will send his address.—G. A. KEYWORTH, Hastings.

Sulphur Springs.—(Reply to T. H.)—You will find in vol. 5 of the "Handwörterbuch der Reinen und Angewandten Chemie," a series of about 200 analyses of various mineral waters, among which are several containing sulphur in some form or other. As regards the therapeutic application of sulphur-containing mineral waters, and mineral waters in general, including the composition of the chief active constituents, we refer you to Pereira's "Elements of Materia Medica and Therapeutics," vol. i. of the 4th, or perhaps later edition, under the heading "Inorganic Bodies—Water," where you will find all the information you desire. Both books here quoted may be inspected at the Library of the Commissioners of Patents.

Composition of Borneite.—(Reply to "Stibium.")—On page 44 of the 5th Edition of Dana's celebrated work on "Mineralogy," the composition of no less than twenty-five samples of bornite (so it is there written), also known as variegated copper ore, purple copper ore, poikilo pyrites, is quoted. It appears that the mineral varies in composition, but essentially contains sulphur, copper, and iron, mixed with more or less gangue. A crystalline sample from Redruth, Cornwall, contained in 100 parts:—Sulphur, 26·84; copper, 57·89; iron, 14·94; gangue, 0·04; total, 99·71.

Precipitating Sulphur.—Have you or any of your readers a good and cheap method of extracting or precipitating sulphur which is held in solution in caustic soda liquor, carbonate soda liquor, and soda-ash *vat* liquors? I am aware that, if any of the liquors are boiled, or otherwise concentrated, to a salt or solid, and are then subjected to heat in a reverberatory furnace, that the said heat, if hot enough, will *burn* out all the sulphur. I am also aware that sulphate of lead will precipitate a quantity of the sulphur; but, both processes being costly for the purpose I require, I write asking if you have or know any cheaper or better method.—CHEMICUS.

MEETINGS FOR THE WEEK.

MONDAY, 20th.—Medical, 8.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology." (Educational Course.)
TUESDAY, 21st.—Zoological, 9.
—— Civil Engineers, 8.
—— Ethnological, 8.
WEDNESDAY, 22nd.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 23rd.—Royal, 8.30.
—— London Institution, 7.30. Mr. F. S. Barff, M.A., F.C.S., "On the Action, Nature, and Detection of Poisons."
FRIDAY, 24th.—Royal Institution, 8. W. Mattieu Williams, "On Rumford's Scientific Discoveries."
—— Quekett Microscopical Club, 8.

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THE CHEMICAL and TOXICOLOGICAL CLASS will meet as usual every Monday and Thursday evening, at 8 p.m., commencing October 3rd.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 587.

AMERICAN ECLIPSE EXPEDITION.

WE owe to the courtesy of the editors of the *Journal of the Franklin Institute* early proofs of a long communication from Professor Young, dated Jerez, December 23rd, 1870. From it we make the following extracts:—

Our party of twelve concentrated at Jerez, some thirty miles (by rail) north of Cadiz, about ten days before the eclipse, and although much interrupted by unfavourable weather, our instruments were in position and adjustment in good season. Mr. Dean, assisted by Capt. Ernst and Mr. Gannett, had in charge the determination of our geographical position, using a 46-inch transit, chronometers fitted with galvanic break circuit apparatus, a chronograph, sextant, &c. The photographic apparatus comprised two telescopes equatorially mounted with clockwork, one of 8 inches aperture, and the other of 6, besides a horizontal telescope of 5 inches aperture, and about 30 feet focus, with a plane unsilvered mirror of glass to reflect the sun's rays into the tube. Messrs. Willard, Mahoney, and Gannett attended to this department.

Professor Pickering observed for the polarisation of the corona with apparatus which, I presume, he has described in his letter to you. He was assisted by Mr. Ross. Professor Langley also observed for the same, and for the general features and structure of the corona.

We had four spectroscopes in the field. Professor Winlock used an instrument with two prisms. This was attached to an equatorial of 5½ inches aperture, which formed a distinct image of the object observed on the slit of the collimator. Mr. Clark assisted him at the finder.

My own instrument was the spectroscope figured and described in a late number of the CHEMICAL NEWS (See vol. xxii., p. 277). It was attached to the Dartmouth College Equatorial of 6½ inches aperture, and, like Professor Winlock's, received a distinct image on the slit of the collimator. The observations previous to totality were made with the whole dispersive power, equivalent to 13 prisms. During totality I used 7. As the observations of Professor Pickering last year had made it a matter of interest to observe the general spectrum produced by the total light coming from the moon's immediate neighbourhood during totality, without any limitations such as are introduced by throwing an image upon the slit, two instruments were mounted for this purpose. The first consisted of the collimator and telescope of my large 9-prism instrument, with two of its prisms. The telescopes have an aperture of 2½ inches, and a focal length of about 17, and the prisms are of proportionate size, having, however, an angle of only 45°.

This was mounted upon a board in such a manner that it could have the slit of its collimator readily pointed toward the sun. As its angle of aperture was about 70°, it required no great exactness of direction and no movement during the totality. This instrument was put in charge of Mr. Abbay, a member of one of the English parties, who, at his own request, was kindly detailed to assist us in the matter, as they had no suitable instrument, and we no spare observer. He brought with him an induction coil and a Geissler tube, prepared under Mr. Lockyer's supervision, which gave the combined spectra of hydrogen, mercury, magnesium, and sodium. This spectrum, thrown into a field of view in the ordinary way, formed the scale of reference. Another smaller instrument was fitted up from a star spectroscope of one prism of very dense glass, with telescope and collimator of the usual size—about 1 inch aperture and 7 focal length. To increase the light I placed in front of its slit a small telescope, magnifying about 2½ times, and having a field of 3½°. This was adjusted carefully for distinct vision on a remote object, and its effect was, *not to form an image on the slit*, and thus to limit the locality from which the observed spectrum was derived to some small point, but merely *to increase the virtual angular diameter of the sun and the total amount of light received on the slit.* This instrument was put in charge of Mr. Pye, a young Englishman who was spending the winter at Jerez, for the benefit of his health. He had had some experience in spectroscopy, and used his instrument very skilfully and effectively. To all these instruments, excepting Mr. Abbay's, was adapted Professor Winlock's beautiful arrangement for recording the positions of the lines observed. A little chisel is brought down by the simple pressure of the finger, upon a siver plate which moves with the telescope, and thus a fine line is made which permanently marks the position of every line which may be upon the cross-wires of the instrument; these plates are preserved, and afterwards read off at leisure by a suitable micrometer.

The day and night previous to the eclipse were very fine, but early in the morning it clouded up. When we arose the prospect was very gloomy—it even rained from time to time.

Just before totality the clouds became much thicker and we nearly gave up hope, but at the needed time, almost by the direct interposition of Providence, it would seem, a small rift in the now heavy clouds passed over the sun, and permitted us to see and observe the sublime phenomenon, if not in all the beauty and grandeur of last year, yet satisfactorily and most gratefully.

During the totality, one good photograph of the corona was obtained with the 6-inch glass, with an exposure of one and a half minutes. It is, of course, by no means so good as it would have been had the sky been truly clear, but it shows a great deal of detail, curved filaments and radial shadings far better than any before obtained. The picture obtained with the 8-inch glass was nearly injured by not being removed until the sun came out.

The details of its structure were not seen this year nearly as well as last by the telescopic observers. The thin cloud shaded out and obliterated definition, without, however, cutting out much light. I think, if anything, it appeared more extensive than then, but much less definite in its outline. Others, however, thought it much less extensive. Its form was as usual, roughly quadrangular—nearly square; but it is a curious fact that its longest diagonal was neither equatorial nor polar, but made an angle of nearly 45° with the hour circle, lying from the N.W. to the S.E. This was carefully determined by Professor Langley.

In respect to the polarisation observations, the appearances in the instruments were much complicated by the cloud and haze, but I believe Professors Pickering and Langley both agree that the corona certainly has a considerable proportion of its light radially polarised.

Our spectroscopic results completely confirm those of last year, except that the two faint lines which I saw between D and E last year, and suspected to be corona lines, as well as 1474, were not seen at all this time. 1474 was traced by Professor Winlock to a distance of near 20′ from the sun's limb. I traced it 16′ on the west, 12′ on the north, 14′ on the east, and about 10′ on the south. The principal chromosphere lines were also visible in the corona to a distance of 3′ or 4′. But Professor Winlock and myself both agree in attributing these to the reflection of the haze around the sun. I am the more confident as to this, because last year in a clear atmosphere the C line was certainly sharply terminated at the upper limit of the chromosphere or prominence under observation. Mr. Abbay, in his spectroscope, saw only the 1474 line and the F line—the former considerably the brighter of the two. He saw no continuous spectrum.

Mr. Pye saw C (8·5); D_3 (5·5); 1474 (10) and F (3). The numbers appended represent the relative brightness

of the lines. All of us, except Mr. Abbay, saw a faint continuous spectrum, but without any traces of dark lines. Still, as far as I am concerned, I should not dare to affirm that there might not have been dark lines without my seeing them, since on account of my using so great dispersive power this spectrum was very faint, except when I divided the slit considerably. With the instruments of Professor Winlock and Mr. Pye the case is different. I do not think, if dark lines existed, they could have escaped them.

No particular examination was made of the chromosphere spectrum, but I noticed it sufficiently to ascertain that there were probably in it, at least in the particular portion under observation, no lines which I had not already seen under ordinary circumstances. I saw C, D_1, D_2, D_3, 1474, two or three of the iron lines near E, the four lines of *b*, the barium lines between *b* and F, and one of the iron lines, often seen there, F, and 2185, which Mr. Lockyer considers a magnesium line. I did not examine the spectrum above this point, nor below C. This was on the eastern limb of the sun, near the point of last internal contact.

Perhaps I may be allowed to interpolate here, that on the previous day I saw in the spectrum a very bright, but small, prominence on the N.W. limb of the sun, the line below C, which I have seen twice before, but have so often looked for in vain that I had more than half concluded myself to be deceived. It is the reversal of the dark line, 656, of Kirchhoff's map. Also, in the same prominence, and for the first time, I believe, the three *chromium lines* just below *b*. Of course, D and D_2, and all the lines of *b*, were very bright in it, as well as many of the iron lines seldom seen.

But the most interesting spectroscopic observation of the eclipse appears to me to be the ascertaining, at the base of the chromosphere, and, of course, in immediate contact with the photosphere, of a thin layer, in whose spectrum *the dark lines of the ordinary solar spectrum are all reversed.*

Just previous to totality, I had carefully adjusted the slit tangential to the sun's limb, at the point where the second contact would take place, and was watching the gradual brightening of 1474 and the magnesium lines. As the crescent grew narrower I noticed a fading out, so to speak, of all the dark lines in the field of view, but was not at all prepared for the beautiful phenomenon which presented itself when the moon finally covered the whole photosphere. Then the whole field was at once filled with brilliant lines, which suddenly flashed into brightness and then gradually faded away, until, in less than two seconds, nothing remained but the lines I had been watching. The slit was very close, and the definition perfect. Of course, I cannot positively assert that all the bright lines held exactly the same position that had been occupied by dark ones previously, but I feel very sure of it, as I particularly noticed several groups, and the whole arrangement and relative intensity of the lines struck me as perfectly familiar. Mr. Pye saw the same thing for an instant only.

This observation is a confirmation of "Secchi's continuous spectrum" at the edge of the sun, and, I think, tends to make tenable the original theory of Kirchhoff as to the constitution of the sun and the origin of the dark lines in the ordinary solar spectrum.

AN EXAMINATION OF THE DOCTRINE OF ATOMICITIES.*

By FRANK WIGGLESWORTH CLARKE, S.B.

DURING the past few years the columns of the CHEMICAL NEWS have contained many papers upon the subject of atomicities. These papers have expressed the widest variety of views upon the doctrine, but have all (or all that I have seen) agreed in one important particular.

They take the body of the theory for granted; and, assuming that the various elements have distinct, definable atomicities, reason from this assumption as from an established fact. The greatest confusion has necessarily resulted. Thus, we have papers proving that sodium is tri- or sept-atomic; or that chlorine is a triad, or that some other element or radical has been incorrectly classified; but none to show whether the regularities and analogies upon which the doctrine of atomicities was first founded were sufficient to form an adequate basis for it. Very naturally, as a consequence of this manner of treating the subject, the theory has grown shadowy and indefinite, it has become difficult to explain coherently, and much of the discussion concerning it has, for want of a well-established starting-point, been utterly fruitless. It is my purpose now to examine briefly the various forms which the theory has assumed, or may assume, and, by comparing them with one another, to endeavour to show how far the main body of it is warrantable.

Now the question to be settled is, how far are we justified in supposing the various elements to possess, inherently and as a positive property of their own, definite atom-fixing powers; and, if such powers exist, how far have we any knowledge of them? If, for the sake of argument, we assume that such powers really belong to the elements, we shall find there are three essentially different modes of regarding them; and a careful comparison of these modes will afford us, not only the best means of learning their value relative to one another, but also the soundest criterion of the worth of the central theory itself.

First, we may suppose each element to have a definite, invariable atomicity. Second, it may be held that the atomicity of a substance varies within certain known or ascertainable limits. And third, it may be said that the atomicity of each element can vary to any extent below a certain definite maximum, whether we are able to attach any value to such a maximum or not.

The first form of the theory is one which, once held extensively, has of late been quite generally abandoned; although still it is accepted by a few authorities. And yet it is perhaps the most typical of the three, and has much higher claims to scientific precision of statement than the more popular second form. But, unfortunately, it is overthrown by the fact that two elements may combine in several different proportions. However, since this fact is sometimes evaded, or, rather, since some chemists attempt to evade it by means of an extra theory which is tacked on to the original doctrine, it becomes necessary for me to consider the nature of the evasion, and its scientific validity.

Let us take the familiar case of the chlorides of iodine, ICl and ICl_3. The two elements forming these compounds being both regarded as monatomic, it is said that in the first compound they saturate each other, the higher chloride being formed by a molecular union of the first with two atoms of chlorine. But, as has been objected by most authorities, if a saturated compound can unite with chlorine, a new force must be called into action, and of the existence of such a force we have no evidence whatever. Suppose, however, that such in addition to the original doctrine should be admitted; then comes forward another compound of chlorine and iodine, ICl_4,* and to account for this we must either invent a third force, or else admit the variable atomicity of one or the other of the elements involved. And a fourth compound of the two elements would call up a fourth force, and so on indefinitely. Over and above these objections it may be shown, I think, that to admit any notion of "molecular union" into the classifying of the higher compounds of any two elements would destroy all certainty in the theory of atomicities. For instance, carbon is called tetratomic. But suppose CH_2

* Read at the Troy Meeting of the American Association for the Advancement of Science.

* A crystalline solid, discovered by Kammerer.

should be isolated, would we not be justified in saying that CH_4 was merely a *molecular* compound of methylene with two atoms of hydrogen, and in looking upon carbon as a dyad? So, then, without stopping to consider any of the other well-known compounds analogous to the trichloride of iodine, we may lay this form of the doctrine of atomicities aside as untenable. But before passing further, it is worth while to notice an important distinctive feature of the view we have just been examining—viz., that a definite standard of comparison exists to form a basis for them. This standard is hydrogen, which, being looked upon as a monad, affords a starting-point for fixing the atomicities of all the other elements. The moment that we admit a variability of atom-fixing power, it is plain that this standard is gone; for we cannot say that the atomicity of every other element varies, while that of hydrogen alone remains stationary.

If we turn now to the second form of the theory, which teaches that the atomicity of a substance may vary within certain known limits, we find the elements commonly divided into two classes, according as their atomicities are represented by even or odd numbers.

Upon this view a monad can become either triad or pentad, but never dyad nor tetrad; while, on the other hand, a diatomic element may be also tetra- or hexatomic, though never tri- or pent-atomic.

But here again we come into collision with certain facts which cannot be set aside. Take, for instance, the chloride of iodine already cited; we have ICl_3 and ICl_4—is the atomicity of iodine even or odd? Vanadium forms three chlorides—VCl_2, VCl_3, and VCl_4; to which class does it belong? How shall we classify the biniodide of phosphorus, and how dispose of plumbo-triethyl and plumbo-tetrethyl? And how shall we account for the fact that, although manganese and chlorine belong in different classes, the permanganate and perchlorate of potassium are not only similar in formula, but are actually isomorphous? Many other examples might be cited in addition to these, but these seem to me sufficient to prove conclusively that no line can be rationally drawn dividing the elements into artiads and perissads.

Now, upon taking all these facts into consideration, it becomes doubtful whether we can ascribe a definite value to the atomicity of any element, and the whole subject grows vague and uncertain; for we have, as I have already suggested, no standard unit of comparison. If we look at any simple compound consisting of two elements, we have to make at least one, and sometimes two, pure assumptions, in order to decide upon the atomicity of either element contained in it. First, we must assume the atomicity of one to ascertain that of the other; and, secondly, in many cases we must take it for granted as to whether the compound may be called "saturated" or not. Take water as an example. If oxygen may have any one of half a dozen different atomicities, and hydrogen any one of as many more, then, in order to decide upon the value of the first element in water, we must arbitrarily select one of several values as the precise one which hydrogen possesses in that particular compound. Or, rather, we have to select two; for water contains two atoms of hydrogen, and we have no possible means of knowing whether these two atoms may not have two different values. And if, to simplify the selection of possibly appropriate atomicities for the two elements, we assert that water is a saturated compound, we make another pure assumption—we contradict the fact that water enters into union with other substances, and we obtain results which are of no more value than mere guess-work. And if we find such difficulties in considering so simple a substance as water, how much more troublesome it would be to write out the atomicities for so complicated a body as one of the silico-tungstates of aluminium, which contains (if formulated empirically) 126 atoms of oxygen and 87 of water of crystallisation.* And some of the so-called "indefinite" compounds would be even more; for instance, such a compound (a veritable *compound*) as Ordway has described, having the formula, $Fe_2Cl_6+23Fe_2O_3$. Such compounds seem to me absolutely inexplicable by any of the ordinary forms of the theory of atomicities; in fact, it seems as if theoretical chemists had actually run away from, or ignored them. They have not yet been firmly grappled with, and cannot be under the restriction imposed by current theories. Many of these compounds bid utter defiance even to the so-called "law of multiple proportion," which law, by the way, has been called in question by no less an authority than Grove.

If what I have thus far put forward be admitted, and we are unable to attach any definite known value to the atomicity of any element, then we are forced to fall back upon the third possible form of the doctrine, that every element possesses a certain maximum value, below which, as far as we know, it may combine in any proportion. But this idea of a maximum, as will at once be seen, is in its essence a necessity; since we cannot conceive that a single atom of one element may unite with an infinite number of atoms of some other. There must be a limit somewhere, although we may not be able to say where it is, and although it may possibly vary with circumstances of temperature and pressure. If we accept the atomic theory, we must believe in atom-fixing powers, and that belief takes shape most naturally and consistently in the idea of a maximum value; and if we reject the conception of atoms, although that rejection would be fatal to the first two forms of the doctrine of atomicities, the notion of a maximum still remains as the simplest expression of a necessary law of chemical union. For under no circumstances whatever can we conceive that a limited quantity of one species of matter can unite definitely with an unlimited quantity of another. So, then, although the first two forms of the doctrine may be objected to on account of their dependence upon another unproved theory, the third form is not essentially affected by any such sources of doubt. The words of the statement may be faulty, while its meaning is not. But, as I have already stated, although we know that maxima of combining power must exist, we cannot in any case establish the value of such maxima, for very obvious reasons. Thus, we cannot say that in CH_4 carbon is saturated, or, in other words, exerts its greatest atom-fixing or combining power, for we have no positive knowledge but that there may yet be discovered a CH_5, or even a CH_{10}. Such future discoveries may be improbable, but we have no adequate reasons for asserting them to be impossible. And we cannot even decide with certainty whether the different elements have one common value, or several different values, for their maxima, although we may have good reasons for surmising differences.

But, after all, although we may be able to ascribe definite atomicities to the elements, what is to be done with the regularities which so plainly connect the elements with one another? Hydrogen, oxygen, nitrogen, and carbon certainly unite together in such ratios that, as a rule, we can call them respectively mono-, di-, tri-, and tetr-atomic, and many other elements follow their lead. There must be a law somewhere to account for these regularities, and that law must do what the theory of atomicities does not, also account for the exceptions to them. The natural laws governing chemical union must certainly apply to all chemical compounds. Yet at present it seems to me that we know little more than that such a law, or laws, must exist. True, we may say that similar elements form similar compounds—a statement which is really the foundation of the doctrine of atomicities. Only that doctrine, as usually held, goes further than the facts warrant, ignores important compounds, and tries to impose limitations where it is by no means certain that any exist. Even this plain rule of similarity is not absolutely invariable; for every chemist knows that nitric acid and its compounds are more closely akin to chloric acid and chlorates than to phosphoric acid and phosphates. So, then, beyond the necessary law of maxima of combining

* See Watts's "Dictionary" upon silico-tungstates

power, and the faint light it sheds, we know no rule which is applicable to all chemical compounds. We are familiar with many regularities and analogies proving that substances are often simply related to one another, but the general law which shall bind them all together in a symmetrical whole is yet hidden in the future. For the present, we may look upon the doctrine of atomicities as a convenient, but faulty, system of mnemonics, which, properly used, enables us to grasp and handle large masses of facts, but which, when misunderstood and regarded as a law, only leads us into confusion. It does not even represent any law, it does not explain anything, it has many faults; but, after all, it is of great value for purely-memorising purposes, although it is liable at any moment to be supplanted by the invention or discovery of something better.

JACOBI'S THEORY OF ELECTRO-MOTORS.

By the Rev. H. HIGHTON, M.A.

(1). SOME time ago I promised an examination of Jacobi's classical paper in *Ann. de Chimie et Phys.*, vol. xxxiv., and I will now carry out my promise as briefly as the subject will allow.

M. Jacobi, as is well-known, was supplied with funds by the Emperor Nicholas of Russia, to construct an electro-dynamic engine, which he did, and applied it to work a vessel on the Neva. His engine was a failure in point both of economy and power; and he wrote to shew that this arose from the necessity of natural laws, and, consequently, that no one else could succeed.

His mathematical investigation of the subject led him to the conclusion that the power evolved by a battery was as the heat and as the expenditure of zinc. This chimed in exactly with the fashionable theory of the age, nearly put a stop to experiments on the subject by really scientific men, and left it to mere empirics. In fact, a successful electro-dynamic engine has been relegated almost to the category of perpetual motion and the philosopher's stone.

I hope to be able to show that Jacobi's conclusions are neither more nor less than a *reductio ad absurdum* of the doctrine of a mechanical equivalent of heat and chemical change.

(2). He shows clearly enough that when a magnet does work it diminishes the intensity of the currents and the consumption of zinc. This he attributes to the production of counter-currents, and investigates mathematically the supposed laws of these counter-currents; and from his premises he works out, in a mathematical shape, all the formulæ connected with the subject, the mathematical expressions for the maximum of work done, for the expense, for the connection between the work and heat, for the most efficient arrangement of the battery, &c. Grant the premises, and his conclusions follow. But it is also quite as clear that, if his conclusions are absurd, his premises and everything drawn from them by mathematical reasoning must be false.

(3). I set out, then, by asserting that his conclusions are absurd. For what is his main conclusion, on which all else is made to depend? It is his formula for the maximum work of an electro-dynamic engine.

This is—

$$T_0 = \frac{n_2 k_2}{4\rho\kappa}$$

in which T_0 = maximum of work; n, number of cells in battery; k, electro-motive force of the elements used; ρ, the total resistance of the circuit; κ, a coefficient depending on the inertia of the iron used in the magnets. Now I say that this great leading formula, on which all his other deductions are based, is utterly absurd, and, therefore, by the *reductio ad absurdum*, disproves his premises and all the conclusions based upon them. For, it will be observed, that, other things being equal, the maximum work varies inversely as the total resistance of the circuit. Now, since the total resistance of the circuit is least when the coils of wire are shortest and thickest, it follows that the shorter and thicker the wires of the coils the more work the engine does, and that it does most work when there are no coils at all! If this is not a *reductio ad absurdum* I do not know what can be. M. Jacobi seems half conscious of this, for he draws attention to it and comments on it; but the absurdity and impossibility of it seems never to have struck him. Well may M. de la Rive call this a remarkable conclusion, that (as he expresses it) the maximum work of an engine should be entirely independent of the number and size of coils; but the absurdity of it seems never to have struck him either. The fact is that the mathematical expression of physical phenomena, unless checked by the utmost care about the premises, is like a powerful but self-willed steed which takes the bit into its mouth and rushes with its rider into a slough of absurdity. Let me add that κ will be found, on examining the reasoning, to be inversely as the inertia of the magnets, and, consequently, there is this second absurdity that the greater the inertia of the magnets the greater the work done by them. But this is a trifle compared with the first absurdity. I should say that in one place his formula is printed—

$$T_0 = \frac{n_2 k_2}{\rho_2}$$

but this seems to be a misprint. Even if correct, it would not affect my main argument—but I think there is no doubt it is a misprint.

(4). I am not bound to show where the error or errors in the premises lie, but I will point out several possible sources of these errors. (1). He assumes the power of a magnet to be represented by $l^2 \times i^2$, l being length of wire in coils, and i the intensity of current. This in actual practice is very seldom, if ever, true. (2). He assumes, without proof, that the diminution of the intensity is due simply to counter-currents. (3). He assumes that the intensity of these counter-currents is expressed by—

$$\frac{\kappa m \beta v}{\rho}$$

where κ is a co-efficient depending on the inertia of the magnets, m the magnetic power, β the length of the wire of the bobbins, v the velocity of motion, ρ the total resistance of circuit. (4). The nearness to which the magnets approach each other in their motion never enters into any of his formulæ, so that the power would appear to be the same if they never approached nearer than an infinite distance. But, above all, he never checked his mathematical conclusions by his practical experiments to see if they agreed. He expressly tells us he did not do so.

(5). He admits that when M. Botto, of Turin, assisted by a committee of *savans*, tested the matter practically, they found that the force did not vary as the consumption of zinc or as the heat, but he sets aside these conclusions by remarking that M. Botto measured the work performed by the number of foot-pounds raised; but that he ought to have taken as his measure the number of foot-pounds multiplied by the velocity with which they were raised, which I need not say is a wholly erroneous view. A foot-pound raised from a state of rest to a state of rest, is a measure of the same total amount of power, with whatever velocity it be raised. The only difference is that in one case a higher force is exerted for a shorter time.

(6). Let me draw the conclusion, then, that having cleared the way by showing the falsity of our ordinarily accepted theories, it remains for us to do what has never yet been done, namely, to establish by a very large number of properly devised experiments, carried out by scientific men combining for that purpose, the true and full laws which regulate the connection between chemical change

in a galvanic battery and magnetic power; and by constructing, as has never yet been done, an electro-dynamic engine, built on really sound principles, to ascertain whether electro-dynamic power can be used conveniently and economically. It is asserted, on apparently good authority, that the practical problem has been most satisfactorily solved in America. Once clear away the fallacious theories now prevailing, and time will soon bring us to sound practical results.

Putney, February 15, 1871.

ON THE

PROPERTIES OF IRON AND STEEL AS APPLIED TO THE ROLLING STOCK OF RAILWAYS.*

By Sir WILLIAM FAIRBAIRN, Bart., LL.D., F.R.S., &c.

DR. JOULE communicated to me the discussion which took place at the last meeting of the Society, on the question of the effects of intense cold on steel tires. This enables me to refer to a series of experiments which had for its object the effects of various degrees of temperature on wrought-iron. These inquiries are, to some extent, analogous to the cause of the recent accident which occurred on the Great Northern Railway, near Hatfield, by the breaking of a steel tire, which caused the death of a number of persons.

It has been asserted, in evidence given at the coroner's inquest, that the breaking of the steel tire was occasioned by the intensity of the frost, which is supposed to render the metal brittle, and of which this particular tire was composed. This is the opinion of most persons, but, judging from my own experience, such is not the fact, and provided we are to depend on actual experiment, it would appear that temperature has little or nothing to do with it.

Some years since I endeavoured to settle this question by a long and careful series of experiments on wrought-iron, from which it was proved that the resistance to a tensile chain was as great at the temperature of zero as it was at 60° or upwards, until it attained a scarcely visible red heat. To show that this was the case, and taking, for example, the experiments at 60°, it will be found that the mean breaking weight, in tons, per square inch, was in the ratio of 19·930 to 21·879, or as 1 : 1·098 in favour of the specimens broken at the temperature of zero.

The generally received opinion is, however, against these facts, and it is roundly asserted that the strength of iron and steel is greatly reduced in strength at a temperature below freezing. The contrary was proved to be the case in wrought-iron plates, and assuming that steel follows the same law, it appears evident that we must look for some other cause than change of temperature for the late fracture of the tire on the wheel of the break-van of the Great Northern Railway.

In our attempt to investigate the cause of the failure it may be interesting to show how the experiments on wrought-iron to which we have referred were obtained at various temperatures, and subsequently to give the results as found in the summary.

The immense number of purposes to which both iron and steel are applied, and the changes of temperature to which they are exposed, renders the inquiry not only interesting in a scientific point of view, but absolutely necessary to a knowledge of their security under the various influences of those changes, and when it is known that most of our metal constructions are exposed to a range of temperatures varying from the extreme cold of winter to the intense heat of summer, it is assuredly desirable to ascertain the effects produced by those causes on material from which we derive so many benefits, and on the security of which the safety of the public frequently depends. It was for these reasons that the experiments in question were undertaken, and the summary of results are sufficiently conclusive to show that changes of temperature are not always the cause of failure, as that which occurred near Hatfield on the Great Northern Railway.

That such is the fact, I may adduce several accidents of broken tires, all of which occurred during the spring and summer months when the temperature was high. One of them occurred on the Lancashire and Yorkshire Railway in the summer of last year when the temperature was 50° to 60° above freezing. I could enumerate others in which the winter frosts had nothing to do with the fractures which ensued.

It might have been satisfactory to have shown the process by which the following results were obtained; suffice it to observe that all the specimens were torn asunder with and across the fibre in oil- and water-baths, and those under the freezing-point were made in a snow bath reduced to zero. The summary of the results is as follows:—

Summary of Results.

No. of the experiments.	Temperature, ° Fahr.	Breakage weight per square inch in lbs.	Breakage weight per square inch in tons.	Remarks. Duration of strain in regard to fibre.
1	0	49·009	21·879	With
2	60	40·357	18·001	Across.
3	60	43·405	19·377	Across.
4	60	50·219	22·414	With.
5	110	44·160	19·714	Across.
6	112	42·088	18·789	With.
7	120	40·625	18·136	With.
8	212	39·935	17·828	With.
9	212	45·689	20·392	Across.
10	212	49·500	22·098	With.
11	270	44·020	19·651	With.
12	340	49·968	22·307	With.
13	340	42·088	18·789	Across.
14	395	46·086	20·574	With.
15	Scarcely red	38·032	16·978	Across.
16	Dull red	30·513	13·621	Across.

From the above it will be seen that the plates from which these results are obtained are much stronger in the direction of the fibre than across it.

The above experiments are quite conclusive as regards the strength of wrought-iron plates till they approach red heat. At that temperature nearly one-half the strength is lost; it becomes exceedingly ductile, and may be drawn to a considerable extent in the direction of the fibres before it breaks.

Another series of experiments were made on wrought-iron bars, which indicated somewhat different results. In these experiments the specimens from the same works attained the maximum of strength, and gave at the temperature of 415° a resistance of 39·072 tons per square inch, and at zero and 60° there were little or no differences, excepting in the case of temperature, when the resistance was increased from 28·419 at zero and 60, to 39 tons per square inch at 415°. This may, however, be accounted for from the increased manipulation of rolling, where the fibre is drawn and elongated to a much greater extent than in plates. This does not, however, affect to any great extent the ratio of compression and extension as regards the effects of temperature, although I should be inclined to take the experiments on plates before that on bars, as analogous to the broken tire, which, it must be borne in mind, is without weld and perfectly homogeneous.

The danger arising from broken tires does not, according to my opinion, arise so much from changes of temperature as from the practice of heating them to a dull red heat, and shrinking them on to the rim of the wheels. This, I believe, is the general practice, and the unequal, and in some cases, the severe, strains to which they are subject has a direct tendency to break the tires.

* Read before the Manchester Literary and Philosophical Society, January 10th, 1871.

To show how easily this may be effected, let us suppose that a tire, two feet six inches or three feet diameter, is shrunk on to a wheel one-tenth of an inch larger than the tire, it then follows that the tire in cooling must be elongated to that extent, with a strain equivalent to the force of the shrinkage, and calculated to produce that amount of molecular disturbance. It may be more or it may be less, but supposing the strain to be one-half or three-fourths of that which would break the tire, it then follows that the constant action of its irregular motion on the rails must ultimately lead to fracture.*

I am not surprised that this should be the case, as most, if not the whole, of railway tires, excepting those on engines and tenders, are not turned but selected by hand, heated and shrunk upon the wheels with every degree of tension, as suits the convenience of the workmen. So long as this process is pursued, the public will be exposed to the risk of broken tires.

What is required in this description of manufacture is, that the rim of the wheel and the inside of the tire should be *turned to a standard gauge*, accurately calculated to give the required amount of tightness with a larger margin of strength, and this done we should attain greatly increased security to the public, and a great saving in wear and tear—to say nothing of the large sums expended by companies in the shape of compensation for injuries and loss of life.

ON FERMENTATION.†

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from p. 67).

In the process of making wine, there are a considerable number of operations which are occasionally considered rather extraneous to normal wine-making, and are by many persons classed amongst frauds. Materials are sometimes used in aid of the natural constituents of the grape-juice, materials which contribute to the quality of the product; some of them by adding materials to it, but others simply removing from the substances bodies which are not wanted in it. And I must say that it does appear to me a great error to object to the introduction of any new conditions which may be found to effect an improvement in the product. I do not think it is reasonable to suppose, because wine is only known by the vulgar as fermented grape-juice, that for that reason nothing but grape-juice ought ever to be used in the manufacture. I think it would be desirable—in fact, it ought to be almost compulsory—that persons should state what materials are present in substances which they sell to the public; but, I think, with that safeguard, it would be right to leave manufacturers perfectly free to employ whatever materials they might find most conducive to the elaboration of their products. In some countries, grape-juice is exceedingly rich in acid and poor in sugar (and I think a good deal of wine is rather of that class), and wine-makers in such districts find that their stuff is more drinkable if some of the acid present in it can be removed before it is sent out. They therefore put into the must, in fermenting the wine, some chalk, and the lime which is present in the chalk combines with the tartaric acid and takes it out of the liquid. Thus, the sour liquid is rendered less sour, and certainly that is not, in any degree, or to any extent whatever, a fraudulent admixture. Nothing is added, but only an unpleasant substance is taken from it. It also happens in precisely the same districts, that from the paucity of sugar which is present in the grape-juice, the wine is too weak in alcohol; and that to meet the requirements of consumers, many wine-makers now add sugar in the process. Now sugar is one of the natural and proper constituents of grape-juice, and if the grapes contain too little of it, it does seem quite proper and desirable that more should be added. However, in the subsequent making of wine, there are several other processes which are less natural than these, and about which some greater difference of opinion may possibly prevail; and one of the commonest, not only amongst wine-makers, but also amongst wine-consumers, is the process of fining. In order to establish the effect and the meaning of this process, I think we must trace back the history of wine from the time in which it is first put into casks by those who produce it to the time at which it gets into the hands of consumers. It is customary—I cannot say whether it is universal or not, but I believe it to be so almost—to put new wine into new casks; and in the better districts oak casks are used. New wood is far more porous than old wood when used for such a purpose. And of course the wine, when put into the cask, sinks into the wood, so that the outer surface is moistened, and allows some of the water and alcohol, and the various volatile materials to evaporate. In fact, the wine diminishes during the first year of keeping in wood very rapidly, by a process of evaporation. But this is not all. Whilst the water and alcohols are evaporating from the outer surface, air is dissolved by the liquid which is in the wood. Air actually diffuses itself through the wet wood into the body of the wine in the cask; and what is more than this, the water and alcohol which go out are replaced by something. The cask does not collapse, nor is there a vacuum produced above the liquid. The wood is always sufficiently leaky for air to come into it, and there is always a space left above the wine. Wine-makers are, therefore, in the habit of filling up their wine-casks periodically. In some districts in France, they are filled up in the first year three times, at three different periods; and, in the second year, they are filled up only twice, but only at perfectly definite periods or seasons, which have been found, for those particular wines, to be most advantageous. But each time the wine, if examined carefully, is found to have undergone, not only what we chemists should call a process of concentration, the solid substances dissolved in the liquid of course always remaining behind, the proportion of liquid being diminished, but, at the same time, it has undergone other changes, that is, there is a deposit formed from it. Some of the bodies present in it, either by themselves or by forming compounds with others added to them, form a sediment, and in the wine-growing districts it is customary, and I have no doubt necessary, to decant the wine and pour it off carefully from the deposit many times, for the presence of the deposit, if continued in the wine, would be injurious to the future changes which it has to undergo. When this comes into the hands of the consumer, there is suspended in the substance of the wine some of this deposit,—some solid particles which might be got to settle down, but which could not easily be removed completely by any process of mere subsidence, and the processes of fining, which are exceedingly various, have for their object the more complete removal of these solid particles by forming compounds with them. In some cases, the process consists in forming what I might call a sort of mordant, or something like a process of dyeing, in which a gelatinous compound is formed in the body of the liquid, which carries down with it a good deal of colouring matter, which it encloses, and which does, while going down, take with it a number of little filaments and cells which were floating in the liquid, and which were so exceedingly light that they would not have settled and could not have been removed otherwise. This point is particularly important in relation to a process which I shall presently mention. In some cases, it has been thought the wine contained too much albuminous matter.

* From long continued action under strain, it has been proved that it is only a question of time when rupture takes place, as repeated increased and diminished changes with the same load ultimately leads to fracture.

† The Cantor Lectures. Delivered before the Society of Arts.

The theory of fermentation which was held for a long time, and which we considered at one of our previous meetings, consisted in attributing the process to the decomposition of the albuminous matter which is present in the fermenting liquid. It was supposed that there was too much of this albuminous matter present, and that it remained and was inclined to do further work. One process which has been adopted to a considerable extent in the champagne districts, where that was supposed to occur, consisted in adding tannin, a substance which I have already spoken of, which carries down a good many albuminous bodies, forming a precipitate with them, and with these no doubt carries down the solids which may be in suspension. Then another process, which really bears a considerable resemblance to this one in principle, although not in form, is that of sulphuring, using sulphur in the casks, which, of course, you would understand at once, exerts an antiseptic action. It is, in fact, a process which consists in producing a material which is, in plain English, a poison to any germs which may happen to be present, whose action must consist, as far as it goes, in arresting the vitality,—in stopping any work which they were doing. M. Berthelot, who has made many accurate experiments regarding the composition of wine and the changes which it undergoes, subjected some wine to the action of a known quantity of air, and by examining the wine afterwards he was led to the conclusion that air is an unmixed evil to wine when once it is fully made. There are certainly many general observations which everybody must have had occasion to make which agree with that. If we open a bottle of wine and use half of it, especially if we leave a bottle of light wine open for some little time, everybody knows that it deteriorates in quality, and becomes flat, or even sour. In a great many cases, it is found that there is a development on the surface of the wine, and if you were to examine it carefully you would easily see, especially in light French or German wines, a pellicle—in fact, the vinegar cells; and their presence must have the effect of promoting the oxidation of the wine. M. Berthelot's experiments confirm the general obervation, which everybody makes more or less definitely, that air is noxious to wine when present in any quantity. But M. Pasteur has arrived at precisely the opposite result. I do not mean to say that he says air cannot do harm, but that what is hurtful in air is the excess of it, or the too rapid rate of its action. He lays down the principle that every ripening of wine, or the process by which young and crude wine is changed into good old wine, consists in a process of slow oxidation; that is its very essence, and that without that, a crude young wine cannot be mellowed or transformed into a good old wine. The evidence which he gives for his conclusion is exceedingly simple, and I must say it appears to me exceedingly conclusive. He has, for the purpose of keeping wine with air, and for the purpose of keeping it without air, resorted to appliances which are far more effectual than those generally resorted to in common life. You may be aware that a cork, even what we should consider a good cork, does not completely prevent the communication of external air with liquids in a bottle. I do not suppose many people can know how much air passes in and through a cork, but the quantity is very great. M. Pasteur sealed up some young green wine, by putting it into a glass vessel, and then he melted up the neck, so that he had no air present with it. He then kept it for a considerable time, and he found that this wine, even after years' keeping, was as green and as young as at first; that wine kept under conditions such as that air could have no access to it did not undergo, to any extent, the change which was wanting, and that it did not improve by keeping. He then sealed up, in a similar vessel, some wine with air, and he subjected the wine, with a known quantity of air, to various influences which were calculated to accelerate the action of the air upon it, and amongst these I ought specially to mention that of light. He took some small vessels made of perfectly clear glass, and sealed up his wine, various qualities of it, in these little vessels with air, and then exposed them to the sunshine in the south of France. He found that the oxygen of the air was totally dissolved, and that, when he examined the air, the oxygen had gone, but he found that his wine then did pass over rapidly into a state exceedingly like that into which it passes by the ordinary process of keeping in bottle. It lost its harshness, and became like old wine, which it resembled very greatly in its quality, and also in its composition the older kinds of wines. At the same time he found that there was formed in such quality of wine a considerable amount of deposit, and his explanation of the way in which oxygen acts so as to improve the quality of the wine is this, that it serves gradually to take away from the wine various substances which are present in it, and that the deposit is due to an oxidation of the colouring matters present, which have an unpleasant, astringent, harsh taste, and it also consists in acting upon the alcohol of the wine and upon the various organic liquids in it in a similar manner. This result is certainly one of very great importance; for if the process of improving wine requires the action of oxygen, and if, on the other hand, the action of oxygen may do much harm—I mean if all the good has to come from the oxygen, and if all the worst evils come from oxygen,—and that really is the position in which the question stands upon our present evidence, it must be of the greatest importance to ascertain what are the conditions under which the beneficial action can be exercised, and what are those under which its detrimental influence occurs. In that respect, both of the observers I have mentioned, and others also, have established some remarkable facts, but in order to appreciate them duly, it will be necessary for you to know something of the general character of compounds to which I must now make allusion.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

February 16th, 1871.

Professor WILLIAMSON, F.R.S., President, in the Chair.

THE following gentlemen were elected Fellows:—W. D. Herman, W. W. Holder, G. Lockyer, jun., W. J. Lockyer, J. E. Mayer, R. Meldola, M. M. P. Muir, W. J. Reynolds, W. Smith, T. E. Thorpe.

The following papers were read:—

"*On the Production of Wood-Spirit*," by E. T. CHAPMAN.—The author began by remarking that the difficulties of obtaining correct information regarding this production are very great: the manufacturers are too jealous to disclose their secrets.

The first points which have to be considered in establishing a distillery are, an abundant supply of wood, and, even more important than this, a ready market within reasonable distance for the sale of charcoal. Charcoal is a bulky article, deteriorates easily by travelling, and, as a rule, has a rather high tariff fixed upon it by railway companies and carriers. An abundant supply of water is also needed. The author then proceeded:—

I would first consider the various kinds of wood employed, and the kind of charcoal produced from it; then the ovens, or retorts, in which it is charred; the condensers; and, lastly, the various methods of separating the wood distillate into its proximate constituents, and rendering it saleable.

In this country, the woods preferred for distilling are oak, beech, birch, thorn, crab, or apple; many other woods are, however, in use, such as hazel, alder, ash, and maple. Excepting under very special circumstances, poplar, elm, and nearly the whole tribe of coniferous woods are not distilled in this country. Holly and yew are highly esteemed for distilling, but are, of course, not sufficiently common to form a serious item in the wood-distillers' consumption.

Oak.—The oak employed is almost invariably either the "lop"—that is the lesser branches of large trees—or the saplings specially grown for their bark. In either case. the greater part of the bark is removed before it comes into the wood-distillers' hands. This peeled oak, as it is called, would probably be used to the exclusion of every other wood, could it be obtained in sufficient quantity and at the same price as other woods; the only objection to it being that its charcoal is brittle, and, therefore, in wood-distillers' phrase, does not measure well. Charcoal *buyers* make no objection to it.

Beech.—I have, personally, no experience of the use of beech-wood, excepting under circumstances which gave me no clue to its value; however, it is reported to be a particularly good wood. It is, I believe, the only wood frequently employed in England in the form of large trees. Such wood is frequently blasted to pieces with gunpowder before use. It is first sawn into such lengths as will go into the ovens; then holes are drilled in the logs, sometimes in the end, sometimes in the side, a charge of powder introduced, and the log blasted. Beech-wood furnishes much tar—it is said to give a particularly large yield of naphtha, and to be the best source of creosote; its charcoal also is good.

Birch.—This wood is, beyond all doubt, one of the very best woods for wood-distilling purposes, if the object be to prepare pure acetic acid, or a pure acetate; the same remark applies to thorn and apple; but it is by no means always the object of the wood-distiller to prepare a particularly pure acetate—consequently, the estimation in which these woods are held varies with the object which the distiller has in view, as will be explained more fully bye and bye.

Coppice woods, generally consisting of a mixture of hazel, alder, ash, and maple, together with smaller quantities of birch, beech, and oak, are very extensively used by wood-distillers. These woods vary in value greatly according to their size; they are, perhaps, of most value when of from fourteen to eighteen years' growth. They are generally cut much too early in this country, sometimes at the end of six years; according to German experience, the greatest yield of wood is not attained until much later.

I think it may be taken as a general rule, hardly liable to exception, that the larger the wood is that is supplied to the wood-distiller the better for him, provided it be not so large that it cannot be charred completely in the twenty-two hours or so during which it is in the ovens.

Roots of trees are occasionally distilled, provided they are not decayed, and are broken up into moderate-sized pieces; they generally furnish a very valuable distillate, and not bad charcoal. The chief objection to them is the great labour required in breaking them up; they are sometimes put into the ovens whole, and heated for forty-eight hours. Decayed woods of all kinds are to be avoided, especially large logs a part of which is decayed; or, at least, great caution must be employed in using them, as the charcoal from them generally proves to be spontaneously combustible. Holly-wood also yields a charcoal which is very liable to spontaneous combustion. The spontaneous combustion of charcoal appears seldom to take place unless perfectly dry charcoal, fresh from the oven (though quite cold and without fire in it), be heaped together in such a manner that the air cannot play freely upon it—put into sacks, for example. It then gets gradually hotter and hotter, and finally catches fire. After being freely exposed to the air for twenty-four hours, the danger appears to be completely averted. Of course, were the combustion due to a spark left in the charcoal, this free exposure to air would certainly cause it to blaze up.

Ovens.—The ovens, or retorts, employed in wood distilling are very various in form; those employed in this country are always constructed of iron, either cast or wrought, and it is a disputed point which is the best material. According to the experience of one wood-distiller, the wrought-iron ovens will hardly last thirty charges; according to another, they have lasted five or six years. The truth, I take it, is that, properly protected by brickwork, and with careful firing, wrought-iron quite equals the cast in endurance; it is, of course, much less liable to crack, and may be made very much thinner than cast-iron. Its disadvantages are, that it easily loses its shape by over-heating, and is somewhat apt to leak at its joints. Wrought-iron ovens are always furnished with cast-iron exit-pipes and doors, as wrought-iron is rapidly attacked by the acid vapours, unless it be sufficiently hot to prevent any condensation upon it. I am not aware that wrought-iron has ever been employed for the construction of any but cylindrical ovens.

Cast-iron is most commonly employed—its advantages are obvious; thus the whole oven may be, and frequently is, cast in one piece, so that there is no chance of leakage from it. Its disadvantages are, that it is apt to crack with the fire, and when cracked it is difficult to repair it satisfactorily; this is especially the case with cylindrical ovens cast in one piece. The ovens we employ are cast-iron; they are square in section, and consist of plates of cast-iron fastened together with bolts and nails.

The following are the dimensions of various ovens that I have either seen and measured myself, or have obtained measurements or drawings of:—

Description of Oven.	Length.	Diameter.	Depth.	Breadth.	Area.
	feet.	feet.	feet.	feet.	Cubic feet.
1. Wrought-iron	7·0	5·00	—	—	137·50
2. Cylindrical ..	9·5	3·50	—	—	91·39
3. Cast-iron ..	10·0	3·50	—	—	96·00
4. Cylindrical ..	10·0	3·10	—	—	115·40
5. — —	4·5	3·00	—	—	31·77
6. — —	7·0	2·50	—	—	34·30
7. Rectangular ..	7·0	—	4·50	3·66	115·29
8. — —	9·5	—	5·00	3·66	174·00
9. — —	10·0	—	4·33	4·33	187·76

Of these ovens, Nos. 1, 3, and 4 have been reported upon very favourably. No. 5 is an old pattern not likely to be ever again constructed, though still in use. No. 6 is a form still used for special purposes, but not now, I believe, excepting for the preparation of special kinds of charcoal; and in one establishment with which I am acquainted two such ovens are retained for burning heavy timber from ship-breakers' yards. No. 7 is not, I believe, an approved pattern. No. 8 is considered to be a very good oven; I believe some constructed on this pattern have been in use nearly twenty years. No. 9 are those employed at our own works; they are the largest with which I am acquainted. I have not mentioned the places where these various ovens are, because in two cases I have been requested not to do so, and in others I have no permission to publish the data. No matter what ovens are employed, they all require to be properly protected with brick-work from the direct action of the fire. No. 1 is protected for two-thirds of its circumference; one fire heats two of these ovens. No. 2 is similarly protected, but each oven has an independent fire. Nos. 3 and 4 are only protected at the bottom; they have a separate fire to each. I have seen ovens of the diameter of No. 4 arranged similarly to No. 1—that is, one fire to two ovens. No. 5 had an independent fire; No. 6 the same. All rectangular ovens have an independent fire for each. As a rule, rectangular ovens are only protected with brick-work as to their bottom plates. The exact arrangement of flues it is not necessary

to describe, further than to say, in general terms, that it is such as to heat the oven as equally as possible.

The author next gave a detailed description of the various kinds of retorts, the mode of charging them, and then continued—

The temperature at which wood is distilled makes a marked difference in the nature of the products obtained from it. Thus I have, in a series of experiments made on oak-sawdust, obtained from 13 to 27 per cent of the sawdust in the form of charcoal, simply by varying the temperature at which the charring was effected. The higher the temperature, the smaller the yield of charcoal; but if the heat be very gradually increased, so that the charring is effected at a low temperature, and the charcoal produced subjected to a high temperature, the yield is invariably only slightly smaller than when the wood has been charred at a permanently low temperature; so that the large yield in the case of the low temperature is not due to imperfect charring. When the wood is very rapidly charred, the amount of liquid which distils from it is always smaller than when it is charred slowly, and the amount of uncondensable gas greatly larger. The amount of acetic acid produced is also larger at a low temperature than a high one.

The maximum amount of naphtha is obtained at a temperature considerably higher than the maximum amount of acetic acid; that is to say, in laboratory experiments where the condensation is of the most perfect kind. But the large volume of permanent gas produced at a high temperature must tend to carry away much of the naphtha with it; still it is generally believed that more naphtha is obtained in a wood distillery, when the ovens are small and highly heated, than in one where the reverse conditions obtain. And, on the other hand, it is, I think, admitted that more acetic acid is obtained with large ovens at a low temperature.

I will now proceed to describe the general process of wood distilling. The vapours which are generated by the action of heat on the wood in the ovens are generally taken off by a pipe from either the upper part of the end, or from the top, and conducted direct into the condensers. Here water, acetic acid, naphtha, and tar are more or less perfectly condensed, but a large volume of permanent gas passes through the condensers. In this country, it is generally allowed to escape; abroad, it is almost invariably burnt under the ovens as fuel. The composition of this gas varies greatly with the time that the wood has been in the oven, and with the heat employed; if a sample of it be collected soon after the decomposition of the wood has commenced, it will be found to be colourless, have scarcely a perceptible smell, and to burn with a blue flame. It consists of a mixture of carbonic acid, hydrogen, and a hydrocarbon, apparently marsh-gas. As the temperature rises, the escaping gas becomes clouded with a tarry smoke; it now burns with a yellow smoky flame. If a sample of it be collected and allowed to stand for two or three days in a bottle, it deposits tar and becomes colourless; and if the temperature of the ovens has been kept very low, it burns with a yellow, slightly luminous flame. It contains carbonic acid and gases absorbable by bromine. After the carbonic acid and the gases absorbable by bromine have been removed, the gas burns with a blue flame like that of alcohol, and consists of a mixture of carbonic oxide and hydrocarbon gases—probably chiefly marsh gas. Towards the end of the operation, the gases are richer in illuminating power, not derived from gases absorbed by bromine. Even right up to the end of the operation, however, the gas, when purified by long standing, treatment with bromine, washing with alcohol, and then with aqueous potash, has very little illuminating power. It does not appear, therefore, that any hydrocarbons of the marsh-gas series of at all complex formula are produced. Carbonic oxide increases in quantity as the operation proceeds; and towards its close, especially if the temperature be allowed to rise rather high, its quantity is very considerable. I have had neither time nor opportunity to make a full and careful examination of the gas, but the foregoing sketch will give a general idea of its nature. I I think I may say that it consists essentially of carbonic acid, marsh gas, and carbonic oxide, with varying quantities of olefines, probably ethylene. The carbonic oxide increases in quantity throughout the whole operation till its close. The illuminating power of the gas, after standing and washing in alcohol, is greatest somewhat before the close; but if the temperature be kept low in the ovens, the illuminating power in the washed gas is never high. Of course the gas is charged with volatile liquids produced during the distillation, therefore it has considerable illuminating power as it leaves the condensers.

The liquid products of distillation, which form two layers —the upper aqueous, the lower tarry—are differently treated according to the object the manufacturer has in view. After having given an exhaustive account, which does not conveniently allow an abbreviation, of the products obtained in wood distilling, the author went on to say that some easier and more exact methods of estimating the commercial values of the various products ought to be introduced.

"*On the Effects of Pressure on the Absorption of Gases by Charcoal*," by JOHN HUNTER. Very numerous experiments lead to the observations—first, that the amount of absorption increases with the pressure to which the gas is exposed; and secondly, the same change of pressure produces about the same amount of increase in the quantity of each gas absorbed.

"*On the Solubility of the Phosphates of Bone-Ash in Water holding Carbonic Acid*, by R. WARINGTON.

NOTICES OF BOOKS.

Victoria.—Abstracts of Specifications of Patents applied for from 1854 *to* 1866, *&c to Bu.* Illustrated by copies taken from the original drawings. Prepared in the Patent Office attached to the Registrar-General's Department, Melbourne. By WILLIAM HENRY ARCHER, Registrar General of Victoria. Melbourne: by authority, John Ferres, Government Printer. 1870.

THE author of this work states that, in selecting the plan of preparation adopted in the present volume, and proposed to be continued in the succeeding volumes of abstracts, two objects have been kept especially in view; firstly, to produce the work in so cheap a form that the mere question of price would not exclude it from the library of an inventor of moderate means; and secondly, to omit no essential item of information contained in the original descriptions. The arrangement of the various divisions is alphabetical (this volume begins accordingly with Accidents—prevention of, and ends with Buoys), but in consequence of the importance of mining as a national industry, it is intended in the second volume, now in course of preparation, to describe all patents relating to the extraction of metals, without waiting till the publication of the letter "M" in ordinary course. The abridgments of the specifications were prepared by Mr. T. Harrison, of this department. We congratulate the people of Victoria, not only on the zeal shown by their officers of the Registrar General's Department in preparing this excellent volume, but also for having carried the matter out with a very decided improvement, viz., the addition of a large number of beautiful photo-lithographic plates exhibiting copies of original drawings added to the specifications: in this respect the people of Victoria are ahead of their brethren in the mother country, and have taken a good hint from the practice so effectually carried out at the Patent Office of the United States. As far as we are able to judge, the abridgments are very well made, and clearly give the essence of the subject matter; the typographical execution of this and of other works issued by this office is highly commendable.

MISCELLANEOUS.

The Abbé Moigno.—From a letter just received from the Abbé Moigno, dated Paris, February 15, 1871, we understand that this distinguished *savant* had a narrow escape during the bombardment. A shell exploded in his bedroom and destroyed more than a thousand valuable books, but he escaped uninjured. *Les Mondes*, the publication of which was suspended last September, will reappear as soon as communications are open. M. Ch. Girard has, we regret to say, received serious injury from the fall of a shell, but our readers will be glad to hear that he is now convalescent.

Magnetic Motive Power.—If we mistake not we are in the dawn of a new and economic motive power. We have long had an instinctive expectation of its approach. Now, by the scientific exposition of the possibility of an infinitive development of magnetic power by an apparently inadequate initial force, as argued by Mr. Highton in the CHEMICAL NEWS of Dec. 2nd, 1870 (vol. xxii., p. 205), and the apparent product of it before our senses, seemingly verifying the argument, we are strongly induced to hail magnetism as the coming worker for millions of men and for purposes innumerable. Some will smile at this. It is right they should. The idea has been discouraged by electric writers as visionary and impracticable. They have asserted the impossibility of any such economic use of material for the production of magnetic power as could ever justify the hope of its substitution for steam. They were right so long as the battery was regarded as the source of power instead of a mere initiative, such as results now seem to prove it to be. Our theories of electro-motive force may require to be re-examined, and, perhaps, changed. The axiom that a given magnetic force is the exact product of a given consumption of zinc or chemicals must now be challenged and put to proof. We confront now this proposition that, although the electro-motive force may be in the battery, yet that the magnetic power which follows its application is capable of indefinite enlargement without increase of the initiative agent. We are brought face to face also with the fact that when a magnet is performing its maximum work the battery which started the magnetic power is most at rest! In other words, that the magnetic power is not proportioned to the size or consumption of the elements of a battery, although dependent upon it as an initial force. We do not pretend to explain this problem, but we can tell what we have seen. It seems to corroborate the recent position taken by Mr. Highton, of England, another of whose articles we reproduce to-day from that excellent paper the London CHEMICAL NEWS, and to prove that we are on the borderland of a new and wonderful series of development of an economic, safe, and efficient motive power. It may prove that our assumed data as to the power resident in our battery materials has been underrated, and their productivity misunderstood. Let us now state what we have seen. A few days ago we accompanied, on invitation, several gentlemen to the works of Mr. H. M. Payne, of Newark, N.J. (The editor here gives a description of a powerful magnetic saw-mill which he saw in action). This rapid and effective action has been watched nine consecutive hours by investigating parties, without any perceptible decline of power, and with a consumption of less than half a pound of zinc, at a cost of less than half a cent per hour. The power developed was rated at two-horse, and can be maintained for twenty-four hours without intermission at a maximum cost of ten cents. Such at least is the statement made to us by Mr. Payne, and confirmed by a well-known gentleman, who thoroughly examined it. By increase of diameter and width, or by multiplication of wheels, and the number of magnets, the power can be largely increased, so we were assured, *by the same number of cells*. This was proven by the fact that, by the addition of wire in the circuit, of sufficient length to surround another set of magnets, no diminution of power was apparent, although the action of the battery was necessarily less; thus another wheel with similar power could have been added. The four cells we saw were stated as capable of maintaining the speed and power produced in our presence for sixty hours without renewal, at the cost of about a single stage-fare on Broadway per day. In this machine, so utterly simple as to challenge the scrutiny of the most ordinary mind, we see the dawn of a new power, capable of endless application at a minimum cost, and destitute of the usual elements of danger. It occurs to us as very strange that what is just being proposed as a possible status of facts by a learned divine in England, should prove the self-same theory which an American citizen has been privately and persistently developing in actual practice for years. To what it may give rise we have no prophet's ken to tell. If the premises demanded are proved to be correct, its application is infinite. We may yet see the Atlantic crossed by huge vessels, propelled without an ounce of coal, by a power the initiative of which the captain may place beside his writing desk in his cabin, which a child can apply, and the littlest finger may stop. The begrimed furnace-man may then come out from these lower hells and walk the deck as clean as the passenger, and the blazing fires be put out. And it may be that in the mysterious workings of the Almighty, these electric forces which are on every hand developing themselves as the life of the world, quickening its pulses from pole to pole, the cause of growth and the cardinal element of a power the limit of which is yet unknown, may be ordained to remove from man part of the curse of toil, unbending the labourer's back, and making him to stand erect as at the first.—*New York Telegraph Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Zeitschrift für Chemie von Beilstein, No. 1, 1871.

This number contains the following original papers and memoirs:—

Electro-Thermic Methods of Analysis and Synthesis.—Dr E. Mulder and F. C. E. van Embden.—The contents of this paper and of the following—

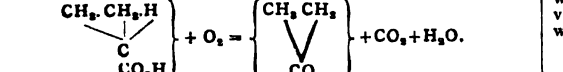
New Method of Quantitative Analysis and Synthesis—Dr. E. Mulder—Cannot be properly understood without the reproduction of the woodcuts illustrating them.

Oxidation of Isobutyric Acid.—A. Popoff.—According to the researches made by MM. Chapman, Markownikoff, and Butlerow on the oxidation of some of the oxy-acids, it appears that the law holds good that those carbon atoms are first and most readily attacked which are already partly combined with oxygen—for instance—

$$\left.\begin{matrix} RROH \\ \diagdown\,/ \\ C \\ CO_2H \end{matrix}\right\} + O = \left\{\begin{matrix} RR \\ \diagdown\,/ \\ CO \end{matrix}\right\} + CO_2 + H_2O;$$

since there exist iso-acids (more correctly, para-isoacids) of the fatty series, the constitution of which is quite analogous to the oxy-acids just alluded to, but contain H instead of HO, presumably, these acids will behave with oxidising materials in the same manner, but will also be more difficultly oxidisable, since none of the carbon atoms they contain are rendered more readily attackable by being partly already combined. This presumption has been proved correct by a direct experiment made by the author with isobutyric acid, prepared by Markownikoff's method, and treated at boiling heat with a mixture of potassium bichromate and dilute sulphuric acid; but, when isobutyric acid in excess is heated in a sealed tube to 140°—150° with an aqueous solution of chromic acid for about twenty hours, and the contents of the tube are next submitted to distillation, and the distillate

saturated with potassa, there is obtained an oily body, boiling at from 55° to 60°, and exhibiting all the properties of aceton. The reaction may be represented by the following formula :—



It is therefore probable that all iso-acids constituted as above mentioned yield, when oxidised, the keton corresponding thereto.

Contribution to our Knowledge of Chlor-Acetamide and Iod-Acetamide.—N. Menschutkin and M. Jermolajew.—This paper treats on monochloracetamide, $C_2H_2ClO.NH_2$, prepared by mixing one volume of pure chloracetic ether with two and a half volumes of concentrated ammonia. The result is the formation of a body crystallising in prismatic crystals; readily soluble in water and boiling alcohol; fusing at 119·5°; subliming without decomposition. Combining with mercury, it forms a compound, $2(C_2H_2ClO.HN).Hg$, crystallising in small acicular crystals, difficultly soluble in boiling water; this solution is not precipitated by sulphuretted hydrogen, and decomposes at 170° with great violence. Iod-acetamide is obtained by treating an alcoholic solution of chloramide (*sic*) with solid iodide of potassium; the resulting body is readily soluble in warm water, from which solution the substance crystallises in prismatically-shaped, large sized, colourless crystals.

Sulpho-Acids of Ortho-Bromtoluol.—E. Wroblevsky.—After referring to a former paper on this subject, the author treats of the salts of the α, β, and γ sulpho-acids of ortho-bromtoluol, and on a nitrited β ortho-bromtoluol meta-sulpho acid. As regards the preparation of ortho-bromtoluol, the author observes that the sulphate of bromdiazotoluol should be decomposed with absolute alcohol, whereby about two-thirds of the theoretically-required quantity of $O.C_7H_7Br$ is obtained.

Pharmaceutische Zeitschrift für Russland, No. 19, 1870.

This number contains no original papers relating to chemistry.

No. 20, 1870.

Contains an original paper on the—

Dissemination of Arsenic in Nature considered in a Forensic Chemical View.—Dr. F. L. Sonnenschein.—This memoir treats chiefly on the way arsenic may become, to a certain extent, the constituent of human bones, and be also found in the soil of cemeteries, and on the method of detecting arsenic in very small quantity in portions of the bones of human skeletons. The broken-up bones are placed in a glass tube, one end of which is sealed up, and which, for a length of 1 meter, has a diameter of 10 m.m. On the bones, perfectly pure and concentrated hydrochloric acid is poured, so that one-third of the length of the tube is left empty. The tube is next gently heated in a water-bath until the carbonic acid is driven off; and when this has taken place, the open end of the tube is sealed before the blowpipe, and next heated in a water-bath to 100° for several days, until the contents are converted into a gelatinous mass. By the sealing of the tube, any volatilisation of chloride of arsenic is prevented. When the contents are thus far dissolved, the top of the tube is cut off with a file, and chlorate of potassa added for the purpose of destroying all organic substance. The rest of the operation is performed in the usual way for the detection of arsenic.

No. 21, 1870.

Contains an original paper on the—

Testing of Essential Oil of Bitter Almonds and Essential Oil of Cloves for Adulterations.—F. A. Flückiger.—As regards the substance chiefly now used for the adulteration of essential oil of bitter almonds, this is the well-known nitrobenzol, or so-called mirbane oil. After referring to a number of tests, devised by various authors, for detecting this admixture, the author states that he employs the following method :—Dilute sulphuric acid (sp. gr., 1·11) is added to granulated zinc; and then the essential oil of bitter almonds to be tested, and the mixture, which is frequently stirred with a glass rod, is, after two hours, poured on a previously thoroughly moistened filter. The filtrate is colourless, provided the heating of the mixture is prevented, which heating is the more readily avoided, since the addition of the essential oil of bitter almonds greatly lessens the evolution of hydrogen. The salt of aniline present in the filtrate (of course, only when the oil was adulterated with nitrobenzol) may be at once detected by the addition of one of the several suitable oxidising agents; the best is chlorate of potassa, which, though not acting immediately, calls forth, even in very dilute solutions, a beautiful rose colour. This reaction is quite sure, even when only 2 grms. of the oil, adulterated with only 1 per cent of nitrobenzol, are tested. These are mixed with 10 grms. of granulated zinc, and 10 grms. of dilute sulphuric acid, and left standing for two hours, care being taken to stir the mixture frequently. As regards the essential oil of cloves, after referring to some of the more common and well-known adulterations of that substance, the author gives an account of some experiments made with the view to try whether it would be possible to detect, by chemical reagents, the adulteration of oil of cloves with carbolic acid; this is done in the following manner :—From 2 to 10 grms. of the oil are shaken up for a considerable length of time with from 50 to 100 times its bulk of hot water. After cooling, the latter is decanted carefully; and, where great accuracy is desired, the aqueous solution is concentrated by evaporation at a gentle heat. To a few c.c. of this liquid a drop of ammonia is added, and next a small pinch of good bleaching powder. If the essential oil were adulterated with even a comparatively small quantity of phenol, the liquid, after having been well stirred up, will assume first a greenish tinge, which afterwards becomes blue, and remains so for several days. Carbolic acid, dissolved in 100 parts of water, assumes, upon the addition of chloride of iron, a beautiful violet colour, which does not appear at all, or not with the proper hue, when essential oil of cloves is present.

No. 22, 1870.

Contains an original essay on the—

Different Kinds of Manna met with in Commerce.—Dr. A. Hausknecht.—This excellent essay contains an account of the various substances designated as manna, and, among these, the author also quotes the manna mentioned in the Pentateuch, and gives some valuable suggestions and information respecting that substance.

No. 23, 1870.

Contains an original essay on the—

Adulteration of some Chemical Preparations Applied in Pharmacy.—Dr. J. F. Martenson.—Among the substances analysed and named by the author we quote the following :—*Acid. phosphor. glaciale purissimum* was found to be perfectly soluble in water; but this solution became turbid by the addition of alcohol, and contained no less than 14·41 per cent of soda, equal to 47·4 per cent of phosphate of soda, and, moreover, alumina and 2·5 per cent of nitric acid. A sample of *acid. nitric. concentr. crudum* contained 1·6 per cent of hydrochloric acid and 5·5 per cent of sulphate of soda. *Tartarus emeticus pulv.* was mixed with 5·5 per cent of cream of tartar and 0·5 per cent of pulverised metallic antimony.

Purified Honey (Mel Despumatum).—Dr. E. Thorey.—The author dissolves the white honey of commerce in its weight of water, and adds to every 2 pounds of this solution 1 drachm of carbonate of magnesia. This mixture is thoroughly shaken up, and, after an hour's rest, is filtered and evaporated to the consistency of a syrup on a water-bath. By this mode of treatment the peculiar flavour (bouquet) of the honey is preserved, and its colour is not impaired as is the case in boiling it. The author also states that direct experiments, made by him with the view to ascertain whether, by the boiling of honey in perfectly clean copper vessels, any of that metal was dissolved and imparted to the honey, prove that such is not the case, while the alteration of the colour of honey by boiling is due to the peculiar colouring matters present in that substance becoming decomposed.

NOTES AND QUERIES.

Artificial Mineral Waters.—(Reply to S. C.)—See Richardson and Watts's "Chemical Technology," vol. i., part 4, pp. 233—266.

Chlorate of Copper.—Will any of your readers be kind enough to inform me if chlorate of copper is used for fireworks, and where it may be obtained?—DELTA.

Precipitating Sulphur.—(Reply to "Chemicus.")—Refer to articles on this subject which were published in the CHEMICAL NEWS, vol. xviii., p. 157; and vol. xix., p. 234.

Colouring of Confectionery.—(Reply to "Innocuus.")—The best yellow for confectionery is saffron. Carmine of cochineal is inert. Indigo is antispasmodic, but weak. Ultramarine is probably inert. —G. A. K.

Colouring of Confectionery.—(Reply to "Innocuus.")—Saffron, anatto, and also the yellow colouring matter contained in safflower and eliminable from it by washing it with tepid water, are innocuous yellow colours; carmine of cochineal, indigo, and ultramarine are also innocuous substances.

Sewage Fungi.—Will any gentleman learned in such matters inform me as to what power is necessary for the detection and identification of sewage fungi under the microscope, and also of other low forms of life in vegetable and other extracts?—PER MARE PER TERRAM.

Manufacture of Alcohol.—Can you inform me if there is any Act of Parliament permitting manufacturing chemists to make their own alcohol from damaged grain or other substances, when it is to be used absolutely in the manufacture of other chemicals or compounds?—R. FISHER.

Testing Gold.—I would feel obliged if any of the numerous readers of the CHEMICAL NEWS could give me a test whereby I could tell the quality of some articles of jewellery, whether they were, say, 9, 12, or 15 carat. I am aware that nitric acid does not act on standard gold, but affects all qualities under that.—INQUIRER.

Mineral Oil.—(Reply to B. S.)—The change alluded to is due to action of the oxygen of the air upon some of the constituents of the oil, which, like many similar and various other organic substances, even though perfectly pure, are by this action, aided by sunlight and temperature, changed in composition, and thereby become dark coloured.

Tar Distilling.—I shall be obliged to any reader of the CHEMICAL NEWS who can suggest a safe and simple plan to prevent my tar stills boiling over. I may say that I never fill them more than two-thirds full, and, no matter how slowly or cautiously they are heated up, they at times boil over without giving the least notice. This occurs oftenest before any naphtha has been given off.—TAR DISTILLER.

Laughing Gas.—Could any of your readers give me full particulars how the liquid gas is made? Fourteen years ago I had it administered in Edinburgh; one or two teaspoonfuls poured into a bladder with a small tube in the neck which, in all cases, was most effective. I have made the dry gas, but it has not the strength, and quite a weak taste compared with what I speak of. Can it be purchased ready made, and where?—READER.

MEETINGS FOR THE WEEK.

MONDAY, 27th.—Medical, 8.
—— Royal Geographical, 8.30.
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology." (Educational Course.)
TUESDAY, 28th.—Royal Institution, 3. Dr. Foster, "On Nutrition."
—— Civil Engineers, 8.
WEDNESDAY, March 1st.—Society of Arts, 8. Mr. A. V. Newton, "On the Patent Laws and their Administration, with a view to the Adoption of Practical Amendments."
—— London Institution, 4. Prof. Huxley, LL.D., F.R.S., "On the First Principles of Biology." (Educational Course.)
—— Pharmaceutical, 8. Dr. Carpenter, F.R.S., "On the Microscope and its Revelations."
—— Microscopical, 8.
THURSDAY, 2nd.—Royal, 8.30.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— London Institution, 7.30. Prof. J. C. Thorold Rogers, "On the Colonial Question."
—— Chemical, 8.
—— Royal Society Club, 6.
FRIDAY, 3rd.—Royal Institution, 9. Capt. Noble, "On Pressure of Fired Gunpowder."
—— Geologists' Association, 8.
SATURDAY, 4th.—Royal Institution, 3. Prof. Jowett, "On Socrates."

TO CORRESPONDENTS.

ERRATUM.—In Mr. Hope's letter of last week for "*Austeckung*" read "*Ansteckung*."

T. Morgan.—1. The report of the Deputy-Master of the Mint can be obtained at Hansard's, Great Queen Street, Lincoln's-Inn Fields. 2. You will probably find the paper in the *Philosophical Transactions of the Royal Society.*

Vox.—Consult "Traité des Arts Céramiques," par A. Brongniart; or "Chefs-Dœuvres of the Industrial Arts," by Philippe Burty, published by Chapman and Hall.

W. Crossley.—Your request shall be complied with.

Cement.—Consult the article on "Cement" in Spon's "Dictionary of Engineering," No. 30, pp. 931-939; or "A Practical Treatise on Concrete, and How to Make it, with Observations on the uses of Cements, Limes, and Mortars," by H. Reid, C.E.; published by Messrs. Spon.

J. Sutherland.—We are obliged for your communication; it shall receive early attention.

Dr. A. Bauer (Vienna).—Received with thanks.

C. T. Kingzett.—You will probably find the information in some of the following books all of which are at the Library of the Commissioners of Patents:—Ure's "Dictionary of Arts, Manufactures, and Mines," 6th edition; Tomlinson's "Cyclopædia of Useful Arts;" Dr. Muspratt's "Theoretical, Practical, and Analytical Chemistry."

Sydney Gibbons (Melbourne).—We are obliged for your letter and enclosure. Your suggestions shall receive attention.

Dr. C. A. Cameron.—We are glad to have an additional proof of the wide circulation of the CHEMICAL NEWS.

Dr. F. Hurter.—We do not know the address of the editor; the journal is published by Wilhelm Diimmler, Berlin. We shall be pleased to have the paper you name.

Domeier and Co.—Received too late for insertion this week.

Chemical Technology, or Chemistry in its Applications to the Arts and Manufactures. By THOMAS RICHARDSON and HENRY WATTS. Second Edition, illustrated with numerous Wood Engravings.

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THE CHEMICAL NEWS.

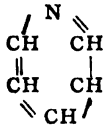
VOL. XXIII. No. 588.

ON THE

CONSTITUTION OF THE PYRIDINE AND CHINOLINE SERIES OF BASES.

By C. R. A. WRIGHT, D.Sc.,

MR. JAMES DEWAR, in a paper read before the Royal Society of Edinburgh, and reprinted in the CHEMICAL NEWS of January 27th (vol. xxiii., p. 38), considers the bases of the pyridine series to be derived from a nitrogenised benzol nucleus—



or benzol where one of the triatomic groups, CH, is replaced by nitrogen. It may be of interest to notice that other modes of representation are equally in accordance with the facts known at present.

First, this series of bases may be regarded as having for their nucleus the four-carbon benzol (unknown as yet) many of whose derivatives are well known—*e.g.*, pyrrol, tetraphenol, pyromucic alcohol, pyromucic acid, carbo-pyrrolic acid, are, respectively, the aniline, phenol, saligenin, salicylic acid, and amido-benzoic acid of the series, thus:—

Pyrrol. $CH{-}C.NH_2$ / $CH{-}CH$

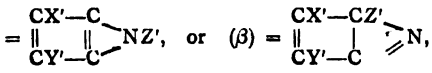
Tetraphenol. $CH{-}C.OH$ / $CH{-}CH$

Pyromucic alcohol. $CH{-}C.OH$ / $CH{-}C.CH_2.OH$

Pyromucic acid. $CH{-}C.OH$ / $CH{-}C.CO.OH$

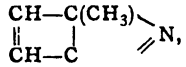
Carbo-pyrrolic acid. $CH{-}C.NH_2$ / $CH{-}C.CO.OH$

Taking X, Y, Z, to represent radicals of the C_nH_{2n+1} series, the general form for bases of the pyridine series may be either—

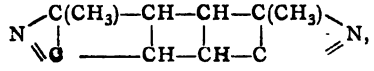


of which, perhaps, the second is the most probable. From either of these general formulæ, numerous cases of isomerism in the higher members of the series may be predicted.

The duplication of the molecule of pyridine is readily accounted for thus:—Assuming pyridine to be—

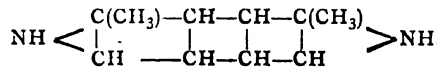


dipyridine would be—

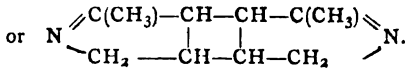


and so on for the other members of the series.

In connection with this, it is observable that the acid, $C_5H_5NO_2$, got by Hübner by the oxidation of nicotine, is either identical or isomeric with carbo-pyrrolic acid, the isomerism (if that be the case) being easily accounted for by supposing a difference in the positions of the NH_2 and CO.OH groups in the two compounds respectively; hence, on this view the following compositions might be attributed to nicotine:—



or

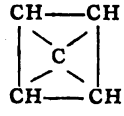


The chinoline series of bases bear to the pyridine series a relation similar to that which the derivatives of diphenyl do to the analogous derivatives of benzol, *e.g.*—

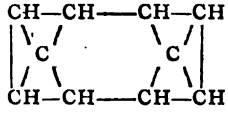
	Aniline.	Amido-diphenyl.
	$C_6H_5(NH_2)$.	$C_6H_4(C_6H_5)(NH_2)$.
	Pyridine.	Chinoline.
(α)	$C_4H(CH_3)(NH)''$.	$C_4(CH_3)(C_4H_3)(NH)''$
(β)	$C_4H_2(CH_3).N'''$.	$C_4H(CH_3)(C_4H_3).N'''$

The isomerism between the two series of bases derived from coal-tar and cinchona respectively, may be accounted for either by supposing different relative positions, &c., in the groups replacing H in the primary hydrocarbon, C_4H_4, or by assuming that one series is of the form (α) and the other of the form (β).

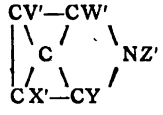
Again, the pyridine series of bases may be considered as being derived from a hydrocarbon, C_5H_4—



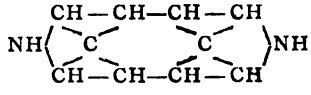
the duplication of whose formula gives rise to naphthaline—



Taking V, W, X, Y, and Z to represent radicals of the series C_nH_{2n+1}, the general formula of the pyridine series will be—



from which very numerous cases of isomerism may be predicted. In support of this hypothesis may be adduced Perkin's production of pyridine from a naphthaline derivative. The duplication of the molecule of pyridine is easily accounted for; thus, dipyridine may be—



As before, the chinoline series may be considered as derived from the pyridine series, by substitution of the four-carbon benzol residue, C_4H_3, for H.

It does not appear from Mr. Dewar's paper that the picoline employed by him was wholly freed from higher homologues, especially lutidine. Probably the dicarbo-pyridenic acid—

$$C_5H_3N\begin{cases}COOH\\COOH\end{cases}$$

obtained by this gentleman was derived from lutidine; if so, the coal-tar lutidine (α lutidine) would be a dimethylised body, probably derived from the hydrocarbon, C_5H_4; for, were it an ethyl-methyl derivative of C_4H_4, the resulting acid would be—

$$C_4HN\begin{cases}COOH\\COOH\end{cases}$$

whilst a trimethyl derivative might be expected to yield—

$$C_4.N\begin{cases}COOH\\COOH\\COOH\end{cases}$$

It is, however, possible that only two methyl-atoms are oxidised by Mr. Dewar's method of treatment, thus yielding—

$$C_4N\begin{cases}CH_3\\CO.OH\\CO.OH\end{cases}$$

Should this be the case, the different resistances of the three methyl groups to oxidation would perhaps indicate a base of the formula (α) rather than of (β); *i.e.*, the third methyl atom would be in association rather with the N, than with the C_4 residue.

It would be of interest to examine the oxidation products of the cinchona lutidine (β lutidine); for, according as an acid isomeric with dicarbo-pyridenic, or an acid $C_5H_4N.CO.OH$ should result, so it would appear that the relations of α and β lutidine are analogous to those of dimethyl-benzol and isoxylol, or to those of dimethyl-benzol and ethyl-benzol, respectively; the difference, in the first case, being simply one of relative position among the groups, replacing H in the primary hydrocarbon, and in the second being a difference in the nature and number of the radicals thus replacing H.

Yet another reason for considering C_5H_4 as the root of the pyridine series is the fact that the lowest member of the series yet obtained contains five atoms of carbon; whilst, had C_4H_4 been the nucleus, a base, C_4H_3N, lower than pyridine, should exist.

ON A REGISTERING SPECTROSCOPE.*

By WILLIAM HUGGINS, LL.D., D.C.L., F.R.S.

THE short duration of the totality of the solar eclipse of December last led me to seek some method by which the positions of lines observed in the spectrum of the corona might be instantly registered without removing the eye from the instrument, so as to avoid the loss of time and fatigue to the eye of reading a micrometer-head, or the distraction of the attention and other inconveniences of an illuminated scale.

After consultation with the optician, Mr. Grubb, it seemed that this object could be satisfactorily accomplished by fixing in the eye-piece of the spectroscope a pointer, which could be moved along the spectrum by a quick-motion screw, together with some arrangement by which the position of this pointer, when brought into coincidence with a line, could be instantly registered.

I was furnished by Mr. Grubb with an instrument fulfilling these conditions, and also with a similar instrument with some modifications by Mr. Ladd, in time for the observation of the eclipse.

Unfortunately, at my station at Oran, heavy clouds at the time of totality prevented their use on the corona, but they were found so convenient for the rapid registration of spectra, that it appears probable that similar instruments might be of service for other spectrum observations.

In these instruments the small telescope of the spectroscope is fixed, and at its focus is a pointer which can be brought rapidly upon any part of the spectrum by a screw-head outside the telescope. The spectrum and pointer are viewed by a positive eye-piece which slides in front of the telescope, so that the part of the spectrum under observation can always be brought to the middle of the field of view. The arm carrying the pointer is connected by a lever with a second arm, to the end of which are attached two needles, so that these move over about 2 inches when the pointer is made to traverse the spectrum from the red to the violet. Under the extremity of the arm fitted with the needles is a frame containing a card, firmly held in it by two pins which pierce the card. This frame containing the card can be moved forward so as to bring in succession five different portions of the card under the points of the needles; on each of these portions of the card a spectrum can be registered.

The mode of using the instrument is obvious. By means of the screw-head at the side of the telescope, the pointer can be brought into coincidence with a line; a finger of the other hand is then pressed upon one of the needles at the end of the arm which traverses the card, and the position of the line is instantly recorded by a minute prick on the card. A bright line is distinguished from a dark line by pressing the finger on both needles, by which a second prick is made immediately below the other. In all cases, the position of the line is registered by the same needle, the second needle being used to denote that the line recorded is a bright one.

It was found that from ten to twelve Fraunhofer lines could be registered in about twelve seconds, and that when the same lines were recorded five times in succession on the same card, no sensible difference of position could be detected between the pricks registering the same line in the several spectra.

It is obvious that, by registering the spectra of different substances on the card, a ready method is obtained of comparing the relative positions of the lines of thin spectra.

The compound prisms employed in both spectroscopes were made by Mr. Grubb, and gave a dispersion equal to about two prisms of dense glass with a refracting angle of 60°.

PS.—I have just learned that in a spectroscope contrived by Professor Winlock for observing the eclipse of December 22nd, 1870, the positions of the observing-telescope are registered by marks made upon a plate of silvered copper.—February 3rd, 1870.

* Read before the Royal Society.

EXPERIMENTS ON THE OXIDATION OF IRON.*

By Professor F. CRACE CALVERT, Ph.D., F.R.S., &c.

SOME two years since, Sir Charles Fox inquired of me if I could give him the exact composition of iron rust, viz., the oxidation found on the surface of metallic iron. I replied that it was admitted by all chemists to be the hydrate of the sesquioxide of iron, containing a trace of ammonia; to this he answered that he had read several books on the subject, in which the statements referring to it differed, and from recent observations he had made he doubted the correctness of the acknowledged composition of iron rust. He further stated that if he took a bar of rusted wrought-iron, and put it in violent vibrations, by applying at one end the fall of a hammer, scales would be separated which did not appear to him to be the substance I had described.

This conversation induced me to commence a series of experiments which I shall now detail. I first carefully analysed some specimens of iron rust, which were procured, as far as possible, from any source of contamination. Thus, one of these samples was supplied to me by Sir Charles Fox, as taken from the outside of Conway Bridge; the other secured by myself at Llangollen, North Wales. These specimens gave the following results when submitted to analysis:—

	Conway Bridge.	Llangollen.
Sesquioxide of iron	93·094	92·900
Protoxide of iron	5·810	6·177
Carbonate of iron	0·900	0·617
Silica	0·196	0·121
Ammonia	trace	trace
Carbonate of lime	—	0·295

* Read before the Manchester Literary and Philosophical Society, January 24th, 1871.

These results clearly show the correctness of Sir Charles Fox's foresight, that the composition of the rust of iron is far more complicated than is stated in our text-books. Therefore the question may be asked. Is the oxidation of iron due to the direct action of the oxygen of the atmosphere, or to the decomposition of its aqueous vapour; or does the very small quantity of carbonic acid which it contains determine or intensify the oxidation of metallic iron? To reply to it I have made a long series of experiments, extending over two years, and which I hope will throw some light on this very important question.

Perfectly cleaned blades of steel and iron having a gutta-percha mass at one end, were introduced in tubes which were placed over a mercury trough, and by a current of pure oxygen conducted to the top of the experimental tube the atmosphere was displaced, and it was then easy to introduce in these tubes traces of moisture, carbonic acid, and ammonia.

After a period of four months the blades of iron so exposed gave the following results:—

Dry oxygen	No oxidation.
Damp oxygen	In three experiments only one blade slightly oxidised.
Dry carbonic acid.. ..	No oxidation.
Damp carbonic acid ..	Slight appearance of a white precipitate of the iron found to be carbonate of iron. Two only out of six experiments did not give these results.
Dry carbonic acid and oxygen	No oxidation.
Damp oxygen and carbonic acid	Oxidation most rapid, a few hours being sufficient. The blade assumed a dark green colour, which then turned brown-ochre.
Dry oxygen and ammonia..	No oxidation.
Damp oxygen and ammonia	No oxidation.

The above results prove that, under the conditions described, pure and dry oxygen does not determine the oxidation of iron, that moist oxygen has only feeble action; dry or moist pure carbonic acid has no action, but that moist oxygen containing traces of carbonic acid acts most rapidly on iron, giving rise to protoxide of iron, then to carbonate of the same oxide, and last to a mixture of saline oxide and hydrate of the sesquioxide of iron.

These facts tend to show that carbonic acid acid is the agent which determines the oxidation of iron, and justifies me in assuming that it is the presence of carbonic acid in the atmosphere, and not its oxygen or its aqueous vapour, which determined the oxidation of iron in common air. Although this statement may be objected to at first sight, on the ground of the small amount of carbonic acid gas existing in the atmosphere, still we must bear in mind that a piece of iron, when exposed to atmospheric influences, comes in contact with large quantities of carbonic acid during twenty-four hours.

These results appeared to me so interesting that I decided to institute several series of experiments.

When perfectly clean blades of the best quality of commercial iron are placed in ordinary Manchester water they rust with great facility, but if the water is previously well boiled and deprived of oxygen and carbonic acid, they will not rust for several weeks. Again, if a blade of the same metal is half immersed in a bottle containing equal volumes of pure distilled water and oxygen, that portion dipping in the water becomes rapidly covered with the hydrate of the peroxide of iron, whilst the upper part of the blade remains for weeks unoxidised; but if a blade be placed in a mixture of carbonic acid and oxygen, a very different chemical action ensues, as not only that portion of the blade dipping in the water is rapidly attacked, but the upper part of it immediately shows the result of chemical action, and also the subsequent chemical reactions are greatly modified by the presence of the carbonic acid. For in this case that portion of the blade is only covered with a film of carbon, together with a dark deposit, composed of carbonate of the protoxide and hydrate of the sesquioxide. The fluid, instead of remaining clear, becomes turbid.

These series of experiments substantiate the interesting fact observed—that carbonic acid *promotes* oxidation.

A long series of experiments were also made to try and throw some light on the curious fact first published by Berzelius, subsequently studied by other chemists, and well known to soap and alkali manufacturers, namely, that caustic alkalies prevent the oxidation of iron; my researches can be resumed as follows:—

(1st) That the carbonates and bicarbonates of the alkalies possess the same property as their hydrates; and (2nd). That if an iron blade is half immersed in a solution of the above-mentioned carbonates, they exert such a preservative influence on that portion of the bar which is exposed to an atmosphere of common air (oxygen and carbonic acid), that it does not oxidise even after a period of two years.

Similar results were obtained with sea water to which had been added carbonates of potash and soda.

ON THE

AMOUNT OF HEAT LIBERATED BY THE ACTION OF OXYGEN ON HYDROCHLORIC ACID.

By FERDINAND HURTER, Ph.D.

IN a paper read before the British Association (Liverpool meeting), Mr. Henry Deacon stated that the reaction—viz., the action of oxygen on hydrochloric acid at a high temperature, and in presence of certain metallic compounds, was itself a source of heat, and that 10,679 units of heat are given out by the decomposition of one equivalent of hydrochloric acid.

M. Jules Thomsen, of Copenhagen,* raised the objection that this amount of heat is not liberated, because, not liquid water is formed, but steam.

This objection rests on a misunderstanding on the part of M. Thomsen, caused by a faulty translation of Mr. Deacon's paper, which appeared in the *Chemisches Centralblatt*.

Mr. Deacon authorised me to reply to M. Thomsen's objections, and I shall try to show the accuracy of Mr. Deacon's statements.

In Mr. Deacon's process, the chlorine and the water are finally obtained at a temperature of 15° C.; consequently the amount of heat liberated is the whole amount above stated, less a few units, which the water and gaseous mixture require to be heated to 15°. Mr. Deacon considered Favre and Silbermann's figures sufficiently near to represent the amount of heat liberated during the whole of the process.

Mr. Deacon was well aware that the water in the decomposing apparatus is in the form of steam, and stated distinctly that the water present absorbs heat, and thus reduces the apparent amount.

He said that the quantity actually liberated is of material assistance to make up for the loss by radiation. This has been translated as follows:—The amount of heat thus liberated *suffices* to make up for the loss of heat by radiation.

That the amount of heat liberated is of material assistance to cover the loss by radiation is proved by the following figures:—

* *Berichte der Deutschen Chemischen Gesellschaft zu Berlin*, No. 19.

	Units of heat.
By the combination of 1 volume O with 2 vols. H are liberated	68,924
By the decomposition of 4 vols. of HCl are absorbed	47,566
Heat set free	21,358

The reaction occurs at about 300° C.

Before the decomposition we have—

	Units.
4 vols. of HCl to be maintained at 300° C. require	4.040
1 vol. of O to be maintained at 300° C. require..	1,047
Total heat required to maintain the mixture at 300° C.	5,087

After the decomposition we have to maintain—

	Units.
2 vols. Cl at 300° C. require	2,585
2 vols. H_2O at 300° C. require	13,158
Total heat required to maintain the products at 300° C...	15,743

The difference in the amount of heat necessary to maintain the reagents and the products at 300° C. is 15,743 − 5087 = 10,656, and this amount of heat does not become apparent in the decomposing apparatus.

The heat which is actually liberated in the decomposing apparatus is 21,358 − 10,656 = 10,702 units.

This heat is sufficient to raise the temperature of the gaseous mixture, including nitrogen, 347° C. It is actually more than that which has to be imparted in order to induce the reaction. This Mr. Deacon termed of material assistance to make up for the loss of heat by radiation.

Laboratory of Gaskell, Deacon, and Co.,
Widnes.

ON THE ROLE WHICH CHALK PLAYS IN BUTYRIC FERMENTATION.*

By O. LOEW.

It is a well-known fact, that a solution of sugar, when not protected against the access of air develops gradually a smell of butyric acid and the formation of micro-organisms. Béchamp† found that one to two drops of creosote or phenol are sufficient to prevent, in 100 c.c. of sugar solution, the development of infusoria and fungi, but that such a small quantity of creosote would not be sufficient to prevent a regular fermentation by yeast. For the latter purpose, much greater quantities of creosote would be necessary.

Béchamp concludes from this observation that small quantities of creosote would kill imperfectly developed micro-organisms, but not the better developed cells of the yeast plant. A series of experiments, however, have shown me that the real cause of the above-named fact depends simply upon the relative proportions of the antiseptic substance and the quantity of the micro-organisms. The quantity of the spores falling from the air into a sugar solution is small in comparison with the number of cells in a few cubic centimetres of yeast. That a given quantity of creosote or phenol can only have a definite and limited antiseptic influence is self-evident, but, as regards these limits, few investigations have been made. I instituted a number of experiments, of which I will mention here a few results:—

(*a*). 300 c.c. of a 5 per cent grape-sugar solution were left standing in a glass-stoppered bottle, which was opened from time to time; soon the presence of micro-organisms could be detected under the microscope and a smell of butyric acid could be recognised; after a lapse of two months, the quantity of decomposed sugar amounted to 9·3 per cent of the whole.

(*b*). A similar quantity of the same solution, as in (*a*), remained entirely unaltered, after the addition of 0·5 grm. phenol.

(*c*). A mixture of 300 c.c. sugar solution of the same strength and 30 c.c. yeast (2·16 grms. dry substance) underwent a regular and complete fermentation, but, after addition of 0·5 grm. phenol, another sample (*d*) went on much slower, and, after two weeks, only 59·5 per cent of the sugar was decomposed by fermentation; on application of 1 grm. phenol, the fermentation was still more retarded, but 5 grms. stopped it entirely.

An interesting contribution to the understanding of butyric fermentation seems to have been made by Béchamp, when he announced small fungi appearing like vibrating dots, which are able to produce butyric fermentation in sugar solutions.

He calls these "microzyma cretæ." Simultaneously he said that the residue of chalk insoluble in acids (0·8 per cent) consists of a body, containing carbon and nitrogen, the real substance of the "microzyma cretæ." It seemed to me interesting to investigate this residue. 100 grms. of chalk, dissolved in hydrochloric acid, left behind 0·82 grms. residue, and this consisted of silica, oxide of iron, alumina, lime, water, and a slight trace of a humus-like substance, the quantity of which was too small to be determined. In order to obtain a clearer insight into the fermenting properties of the chalk, 50 grms. of it were mixed with 300 c.c. of a 5 per cent sugar solution and left to itself (*e*). After a few days, a development of gas bubbles could be observed, and a smell of butyric acid; after two weeks 29·3 per cent of the sugar was found to be decomposed by fermentation.

In another experiment, (*f*), 0·5 grms. phenol were added, the other circumstances being the same. A fermentation set in very soon and the 0·5 grm. seemed to have but very little influence, which agrees with the fact, described by Béchamp, but for which an entirely different explanation must be given than he gave. After two weeks 22·7 per cent of the sugar was decomposed by fermentation. On the addition, however, of 5 grms. phenol, the fermentation was entirely stopped. In a further experiment, (*g*), the chalk was heated with the sugar solution, for a length of time, to 100° C. and set aside in a well-closed flask. No fermentation set in, but, after lifting the stopper from time to time, unmistakable evidences of fermentation showed themselves, and even an addition of 0·5 grm. phenol could not prevent the process.

In the next experiment, (*h*), the chalk was at first heated to 250° C., then, after cooling, left in contact with the atmosphere for a short time, and then brought into the sugar solution, which had been previously boiled and allowed to cool in a well-closed flask; here the same fermentation made its appearance, as mentioned in (*e*) and (*f*).

It seems to me to follow, undoubtedly, from these experiments:—

(1). That Béchamp, while powdering his piece of chalk, taken from the interior of a great lump, gave admittance to the spores contained in the atmosphere, which latter produced fermentation.

(2). That the effect of the small quantity of phenol which in *absence* of the chalk would have been sufficient to prevent fermentation, was destroyed, the phenol having been absorbed by the pores of the chalk. The phenol, thus absorbed, was no more able to prevent the development of the spores falling from the atmosphere into the sugar solution.

Béchamp maintains that a small quantity of creosote would kill the spores coming from the atmosphere, but would be unable to kill the "microzyma cretæ." Further, he says, that powdered marble could not replace the chalk, the latter only containing the "microzyma." It will be

* Communicated by the author, having been read before the Lyceum of Natural History of New York.
† Jahresber., 1865.

seen very clearly, that a small quantity of phenol is easier absorbed by the porous chalk than by the powdered marble. On the other hand, leaving the creosote or phenol entirely out in both cases, the fermentation proceeds equally well, after the chalk as well as the marble had been exposed for a short time to the atmosphere.

(3). That in the presence of a lime salt, the fermentation is accelerated, when once initiated by the spores of the air, the development of the cells being much favoured by the neutralisation of the butyric acid, and by the presence of a lime-salt in solution, as butyrate of lime. Compare (*a*), (*e*), and below (*i*).

(4). That the nitrogenised matter necessary for the development of the cells is not originally present in the chalk, but is derived from the sugar, which always contains traces of it.*

In order to furnish a further proof that phenol absorbed by porous bodies has no antiseptic qualities, 50 grms. of powdered charcoal, which, for some time, had been exposed to the air, were brought into 300 c.c. of a 5 per cent sugar solution, which had been previously boiled, and was allowed to cool in a well-stoppered flask, and 0·5 grm. phenol added; after a few days, the development of gas bubbles could be observed, the phenol smell disappeared and butyric acid could be distinctly recognised by the odour; after four weeks, 23·1 per cent of the sugar was decomposed. Doubtless the presence of a small quantity of carbonate of lime would have accelerated the fermentation. In another experiment, 5 grms. phenol were employed, under similar circumstances, but then, not the slightest fermentation could be observed: it was clear the absorbing power of the coal was overbalanced.

Béchamp employed 80 grms. sugar, 1500 cc. creosote-water, and 140 grms. chalk, and obtained, after two months, 2·6 c.c. alcohol, 4·5 grms. butyric acid, 6·8 grms. acetate of soda, and 9 grms. lactate of lime. This would correspond to 40 per cent of the decomposed sugar. How is it possible for another than a neutralising *rôle* for the chalk, the common butyric fermentation being over in one to one and a-half weeks, and even, if the "microzyma cretæ" would exist, for which, however, I looked in vain. In all my experiments, I found only the common butyric ferment formed by the spores of the atmosphere.

ON THE

ALLEGED ACTION OF COLD IN RENDERING IRON AND STEEL BRITTLE.†

By J. P. JOULE, D.C.L., F.R.S., &c.

As is usual in a severe frost, we have recently heard of many severe accidents consequent upon the fracture of the tires of the wheels of railway carriages. The common-sense explanation of these accidents is, that the ground being harder than usual, the metal with which it is brought into contact is more severely tried than in ordinary circumstances. In order apparently to excuse certain Railway Companies, a pretence has been set up that iron and steel become brittle at a low temperature. This pretence, although put forth in defiance, not only of all we know of the properties of materials, but also of the experience of every-day life, has yet obtained the credence of so many people that I thought it would be useful to make the following simple experiments:—

1st. A freezing mixture of salt and snow was placed on a table. Wires of steel and of iron was stretched so that a part of them was in contact with the freezing mixture, and another part out of it. In every case I tried the wire broke outside of the mixture, showing that it was weaker at 50° F. than at about 12° F.

2nd. I took twelve darning needles of good quality, 3 inches long, 1-24th of an inch thick. The ends of these were placed against steel props, 2½ inches asunder. In making an experiment, a wire was fastened to the middle of a needle, the other end being attached to a spring weighing machine. This was then pulled until the needle gave way. Six of the needles, taken at random, were tried at a temperature of 55° F., and the remaining six in a freezing mixture, which brought down their temperature to 12° F. The results were as follow:—

Warm Needles.	Cold Needles.
64 oz. broke.	55 oz. broke.
65 ,, ,,	64 ,, ,,
55 ,, ,,	72 ,, ,,
62 ,, ,,	60 ,, bent.
44 ,, ,,	68 ,, broke.
60 ,, bent.	40 ,, ,,
Average 58½	Average 59½

I did not notice any perceptible difference in the perfection of elasticity in the two sets of needles. The result, as far as it goes, is in favour of the cold metal.

3rd. The above are, doubtless, decisive of the question at issue. But as it might be alleged that the violence to which a railway wheel is subjected is more akin to a blow than a steady pull, and as, moreover, the pretended brittleness is attributed more to cast-iron than any other description of the metal, I have made yet another kind of experiment. I got a quantity of cast-iron garden nails, 1½ inches long, and ¼th of an inch thick in the middle. These I weighed, and selected such as were nearly of the same weight. I then arranged matters so that by removing a prop I could cause the blunt edge of a steel chisel, weighted to 4 lbs. 20 zs., to fall from a given height upon the middle of the nail as it was supported from each end, 1/8th of an inch asunder. In order to secure the absolute fairness of the trials the nails were taken at random, and an experiment with a cold nail was always alternated with one at the ordinary temperature. The nails to be cooled were placed in a mixture of salt and snow, from which they were removed and struck with the hammer in less than 5″.

Up to Series 10, each set of sixteen nails was made up of those of the previous set which were left unbroken, added to fresh ones to make up the number.

Series 1. Temperature of eight cold nails 10°. Of eight warm 36°. Height of fall of hammer 2 inches.
Result. No nails broke.
Series 2. Temperature of eight cold nails 14°. Of eight warm ones 36°. Fall of hammer 2½ inches.
Result. No nails broke.
Series 3. Temperature of eight cold nails 2°. Of eight others 36°. Fall of hammer 3 inches.
Result. One cold nail broke. No warm one broke.
Series 4. Temperature of eight cold nails 2°. Of eight others 36°. Fall of hammer 3½ inches.
Result. Two cold nails broke. One warm one broke.
Series 5. Temperature of eight cold nails 2°. Of eight others 36°. Fall of hammer 4 inches.
Result. One broke of each sort.
Series 6. Temperature of eight cold nails 0°. Of eight others 38°. Fall of hammer 4½ inches.
Result. One broke of each sort.
Series 7. Temperature of eight cold nails 2°. Of eight others 36°. Fall of hammer 5½ inches.
Result. No cold nail broke. One warm nail broke.
Series 8. Temperature of eight cold nails 2°. Of eight others 40°. Fall of hammer 6½ inches.
Result. Two cold nails broke. One warm nail broke.
Series 9. Temperature of eight cold nails 2°. Of eight others 40°. Fall of hammer 7½ inches.
Result. Three cold nails broke. Three warm nails broke.

* The fungoid growth, observed by every chemist in the solution of tartaric acid, contains in the dried mass 3·5 per cent nitrogen, besides some silica, carbon, &c., even when the acid is commonly considered as "pure."

† Read before the Manchester Literary and Philosophical Society, January 10th, 1871.

Series 10. Experiment with the ten left in the last. Temperature of five cold nails 2°. Of the five others 40°. Fall of hammer 8¼ inches.

Result. Two cold nails broke. One warm nail broke.

Series 11. Experiment with the six left from the last. Temperature of three cold nails 3°. Of the other three 40°. Fall of hammer 10 inches.

Result. Two cold nails broke. Three warm nails broke.

Series 12. Experiment with fresh nails. Twelve cooled for four hours to 3°. Twelve others 41°. Fall of hammer 7 inches.

Result. Seven cold nails broke. Eight warm nails broke.

The collective result is that twenty-one cold nails broke and twenty warm ones.

The experiments of Lavoisier and Laplace, of Smeaton, of Dulong and Petit, and of Troughton, conspire in giving a less expansion by heat to steel than iron, especially if the former is in an untempered state. Such specimens of steel wire and of watch-spring as I possess expand less than iron. But this, as Sir W. Fairbairn observed to me, would in certain limits have the effect of strengthening rather than of weakening an iron wheel with a tire of steel.

The general conclusion is this—Frost does *not* make either iron (cast or wrought) or steel brittle, and that accidents arise from the neglect of the companies to submit wheels, axles, and all other parts of their rolling stock to a practical and sufficient test before using them.

ON THE ESTIMATION OF THE ACETIC ACID IN ACETATE OF LEAD.

By HENRY SEWARD, F.C.S.

Two kinds of acetate of lead are usually offered by chemical manufacturers, the one compact and very heavy, the other in loose crystalline masses; the former is more basic, and sold at a considerably lower price than the other; occasionally, also, products of intermediate composition or, perhaps, mixtures of the above are met with. For the examination of samples of acetate of lead I have used, for the last year or two, a very convenient titration process, which is conducted as follows:—

In a flask of about 12 ozs. capacity, 100 grains of the sample is dissolved in 4 ozs. of distilled water by the aid of gentle heat; litmus solution is then added, and a standard carbonate of soda solution added very gradually. It might be supposed that the presence of a precipitate would obscure the reaction, but this is not the case; one drop of the carbonate of soda solution in excess changes the colour from the purplish neutral tint of litmus to a pale blue. As in all titrations, the best results are obtained when a second determination is made, but I think that this process will be found to satisfy all requirements.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Continued from p. 91).

When we were examining the process of oxidation, I spoke to you of alcohol as a substance eminently capable of undergoing oxidation, and showed you how readily it could be burnt to a much smaller extent than that to which we are in the habit of burning it. I had to mention ordinary acetic acid as being a product of a shorter combustion. Here is a vinegar-plant which is oxidising under alcohol, and there is an intermediate body which I have not yet spoken to you about specially. Here in this, I have some of it dissolved in alcohol. It is a substance which, in the strong state in which I have it here, has rather a sickly odour, and it was named by Liebig, to whom we owe some of the first and most accurate facts in relation to it, aldehyde, a name serving to recall one of the most important facts about it, viz., that it is alcohol from which hydrogen has been taken away. If you were to take away from alcohol some of its hydrogen, you would have aldehyde,—it is alcohol minus one-third of hydrogen, and it is, therefore, alcohol de-hydrogenised, and that is the origin of the term. When wines are undergoing very slow oxidation, it appears that aldehyde and other bodies analogous to it are formed. A great deal of evidence has been adduced of this, but I ought to mention that as yet one link in the chain of evidence is wanting, which chemists are always anxious to get in proof of their conclusions, that is, the substance itself, in a pure state, has not been obtained from wine. Still, the proof is so far conclusive that we are prepared to admit it provisionally. One fact which I mentioned to you just now is very remarkable, as part of the evidence, viz., that wines which are particularly good, either by keeping or by their own composition, combine with oxygen which is dissolved in them. Now, aldehyde is particularly greedy of oxygen. If you were to dissolve in the aldehyde in this bottle some air, and if you were to try to get the air out of the alcohol again, you would find that you could get the nitrogen of the air out again completely if you went properly to work, but you could not get the oxygen out. The oxygen is laid hold of and digested so rapidly by the aldehyde that it is no longer to be recovered, after even a very short interval of time.

I might show you one case of the avidity with which this aldehyde absorbs oxygen, On putting into a glass a solution of nitrate of silver, and then adding a little ammonia, we should find, on pouring into it a little of this aldehyde dissolved in alcohol, there would be a deposit of metallic silver around the inside of the glass. This is a very common and easy way of ascertaining whether in a mixture any body of this class is present. The ammonia liberates the oxide of silver from the nitrate, and the aldehyde acts by taking away the oxygen and precipitating the silver, and in this way we get evidence of the greediness with which aldehyde takes up oxygen. There are several other interesting reactions of this aldehyde, and amongst them I ought specially to mention one which was discovered some few years ago by some very distinguished Italian chemists, the action of which is most exact and clear for removing aldehydes from any substance in which they are present; that is, their combination with alkaline bisulphites. This common aldehyde, and every body of the same class, combines with bisulphite, and forms very definite crystalline compounds, by which they are very easily detected and removed.

When we oxidise alcohol very slowly and gradually, we are able to get aldehyde formed from it; and, in the ordinary process of keeping wine, when it undergoes that slow oxidation which Pasteur affirms to be the proper process, aldehydes are proved to be present in it; but, together with them, there are a considerable number of other bodies, which we are in the habit of calling ethers. I have spoken to you already about some ethers; for instance, the compound which sulphuric acid forms with alcohol; that is a kind of ether, although it is not one of the bodies we are commonly in the habit of so describing. Ethers present a class of bodies which are certainly amongst the most pleasant of chemistry. I have a good many here; one is the commonest of all; it is the ether which is, I believe, present, to judge by the flavour at any rate, in the celebrated *Lachryma Christi*. It is a body which I might describe as a salt. It is a salt formed whenever hydric acetate, the hydrogen salt of acetic acid, is present for a sufficiently long time in alcohol. Whilst the alcohol of the wine is becoming oxidised, and whilst aldehydes are being formed from it there is also formed some acetic acid, and also probably some valerianic acid, butyric acid, and others analogous, which are formed by the oxidation of the bodies present with the alcohol. Al

* The Cantor Lectures. Delivered before the Society of Arts.

these acids, while undergoing the process by which they are formed, combine with the alcohol and bodies like it and form these ethers; and it has been already shown that, at all events, in some cases the aroma of the wine is dependent upon the presence of bodies of this kind. One of the most remarkable processes of manufacture of bodies of the kind which has been successfully performed of late, is the process of preparing artificial ethers, for the purpose of imparting to alcoholic liquids the same flavour, aroma, or bouquet which they are found to possess when made from the same natural substance; for instance, oil of brandy is got from the skins and seeds of the grape which are left when the grape-juice has been pressed out. They are fermented, and a quantity of alcohol and aromatic substances are formed by the fermentation, and this forms the so-called oil of brandy, which is used for making brandy artificially; that is, common corn spirit is flavoured with it, and sold as genuine cognac. In like manner, various kinds of these acids have been made, and there is now in Germany a manufactory for making butyric acid on a large scale from sugar; it is then made into this ether, which is a very fragrant substance, and then in small quantities it is used for flavouring various alcoholic liquids, in imitation of natural products which naturally would possess the same substance or a similar one in them.

Amongst the processes which are detrimental to the quality of wine, I have already mentioned the excess of air having access to it. That is the one which is most known, and against which people least need to be cautioned; but it has been found by wine-growers and wine-makers, especially in the case of higher-class wines, like those of Burgundy and some other districts, that they are liable to particular maladies which produce evils, each one peculiar and different from the others. Amongst these maladies, the first and simplest of all, is acetification, or the transformation of the alcohol into acetic acid. That is one which is so well known now, and so well understood, that, I think, wine-growers are well able to guard against it with tolerable completeness. By the use of a microscope, these little acetic cells on the surface of the liquid would at once be seen, and you would know, of course, that there would then be a tendency in the wine to pass over into acetic acid, and that, unless those cells are removed, or if they are present, unless oxygen be excluded,—because the presence of the cells does not of itself make the wine into vinegar, it is necessary that they should be present with a continuous supply of air,—so that if they are removed, or if you prevent a supply of air, that malady is arrested or cured. But there is another malady which is well known, and frequently spoken of amongst wine-growers as the "turning" of wine. It is a process which is, in its general features, something analogous to acetification, but chemically it is very different. When the wine is put into casks, it begins to give off gas, and in French they call it *la pousse*; it pushes out the ends of the casks, and, if a hole were made, the wine would be ejected with considerable force. M. Pasteur has examined not only the wine itself when undergoing this process, but also the deposit, the little solid particles which are present in it, and he has found two things which are correlative to one another,—in the first place, that there is always present in wine which is suffering from this malady certain little films, which can be seen quite distinctly by the microscope, and which are different from any particles found under any other conditions, and which he therefore believes to be little organic bodies, just as much as in the alcoholic ferment or acetic ferment, and he calls them the ferment of the turning or *la pousse*. That is one fact which is established. These little particles are compared in their structure to little bamboos, as they consist of little straight joints one at the end of the other, the length being considerably greater than the diameter; they are not little spherical matters, like the wine ferment, and their diameter is exceedingly small, being about the one-thousandth part of a millimetre. That is one fact which M. Pasteur has established, and the other is this, that while this process is going on, lactic acid is present; and his explanation of the malady consists in attributing it to the presence of this particular parasite in the wine, which is transforming the materials of it into lactic acid, with no doubt some other product, at the same time. Another malady which not frequently occurs in wine, is ropiness; and it is said that wine suffering acutely from this malady might almost be mistaken for oil, when poured from one vessel to another, so thickly does it flow. That peculiarity is attributed solely to the presence in it of a number of little films peculiar to it; but they are very different to the eye, and very different also in their functions from the films which constitute the active agency of the process I have just mentioned, that of turning. These little films are like little strings of beads, little spherical particles, a great number of them joined end to end. The particular nature of the transformation which the wine undergoes has not been investigated, but, as far as M. Pasteur's observations go, and they are very numerous and accurate, these little strings of beads are really active agents in that particular transformation which constitutes ropiness, and which destroys wine; for, if it cannot be arrested, the wine ceases to be drinkable, and becomes worthless. The fourth malady, which is also one of frequent occurrence, is one which produces a bitterness, and it is said that this malady is one to which wine is subject in its youth and also in its old age; that it sometimes occurs when wine is two or three years old, and sometimes, though in a less acute form, when it is very old. Here, also, a particular parasite is present, little organised particles, which have been minutely described and depicted, and they are found in various states, some differing very much from the others. Some pictures of the parasites which constitute the bitter ferment are like little branches with a number of little knobs or warts upon them, and some of them are clear and transparent, whilst others are coated with an incrustation. M. Pasteur, however, has already shown that the little knobs or warts upon them and the incrustation which frequently occurs, are nothing else than foreign matter deposited upon them, and when the parasite dies it is liable to be encrusted, but that in a pure state it is clear and transparent. This parasite, when it occurs in young wine, renders it completely worthless, but when it occurs in old wine, it only gives such an amount of bitterness as is not fatal to the wine, and is, to a certain extent, exceedingly common, so that it is considered almost a natural accompaniment of old wine. Amongst the remedies for these processes is sulphurous acid, which, of course, would destroy parasites when they are present. We can quite understand that wine which has got germs of these little organic beings present in it is liable to undergo these injurious changes if the germs are allowed to develop themselves, but that it would be free from all such tendency if, by any poisonous material, the little germs or organisms were destroyed. We can also understand that any mechanical process of filtration, or of forming in the liquid a gelatinous mass which will subside and carry down with it any fine particles which may be present in suspension, but which are too light to settle of themselves, would effect the same object; and it is quite intelligible, that if Pasteur's view is correct, that these little solid particles are the active agents of those transformations, the processes which have commonly been in use for preventing the detriment of wine by such changes should be effectual; we can quite see why they ought and indeed must be effectual, but, at the same time, we cannot help seeing that they would be very liable to be incomplete. Of course, it is a matter of chance whether, if you form a precipitate in the liquid, the little light particles would all happen to be caught by some of this precipitate when going down. We should expect that any such process would be efficacious in diminishing the evil, but not in arresting it completely, and I believe that is exactly what is found by experience.

(To be continued).

PROCEEDINGS OF SOCIETIES.

ROYAL IRISH ACADEMY.

THERE was a general meeting of this Society held on Monday, the 13th ult.

Mr. C. E. BURTON sent a communication "*On the Results Obtained by the Agosta Expedition to Observe the Recent Solar Eclipse.*" The other scientific papers were connected with the subject of *Eozoon Canadense.*

(1). One by Professor W. KING and T. H. ROWNEY "*On the Geological and Microscopical Structure of the Serpentine Marble of Ophite of Skye.*"

(2). Principal DAWSON, of Montreal. "*On Eozoon Canadensæ.*"

(3). Dr. H. HUNT, "*On Messrs. King and Rowney's Paper on Eozoon Canadensæ.*"

Professor W. King and Mr. Rowney, take up the position that *Eozoon canadense* is not an organism, but is simply the result of chemical and physical phenomena which produce the appearance known under that name. These two gentlemen have brought a combination of knowledge to bear upon the subject which is invaluable in connection with a disputed question.

ROYAL DUBLIN SOCIETY.

ON Monday evening, the 20th ult., there was a scientific meeting of this Society. Dr. C. King in the chair.

A discourse was delivered by Dr. ALEXANDER MACALISTER "*On Recent Advances Made in Comparative Anatomy.*" Dr. Macalister's important discoveries in connection with this science (described some time since at the Royal Irish Academy) rendered his discourse doubly interesting. His own researches are some of the most important made in this direction for some years. The subject being, however, foreign to the objects of the CHEMICAL NEWS, we must pass to the next paper, which was by Mr. JOHNSTONE STONEY, F.R.S., "*On Recent Discoveries with the Spectroscope.*" In this paper the author described one of his own investigations in connection with the absorption spectrum of chromochloric anhydride, CrOCl. This substance, which boils at 118° C., is a mobile red liquid by transmitted light, but is nearly black by reflected light. It gives off yellowish red vapours having a specific gravity of 5·48.

Mr. Stoney's interesting remarks in connection with this substance were to the effect that the yellowish-red vapour gave a spectrum—all of which were to be referred to a single series of lines—all of which were to be referred to a single motion within the molecule of the gas. The periodic time of the motion was rather more than the million-millionth of a second, and it had been possible to ascertain that the vibrations which it impressed upon the ether resembled the motion of a violin string nearly one-fifth of the length of the string from the end.

NOTICES OF BOOKS.

Chemical Phenomena of Iron Smelting; an Experimental and Practical Examination of the Circumstances which Determine the Capacity of the Blast Furnace, the Temperature of the Air, and the Proper Condition of the Materials to be Operated upon. By I. LOWTHIAN BELL. Newcastle-upon-Tyne: M. and M. W. Lambert, 50, Grey Street. 1871.

THE work before us contains, in 148 octavo pages, the first portion of an interesting and highly valuable contribution to metallurgical science and practice, from the hand of one of the most competent men to deal with this subject—the well-known ironmaster and chemical manufacturer whose name is mentioned above. In order to give our readers some idea of the bearing of this work, we quote from the first section (the introduction) the following:—

"My occupation as a pig-iron manufacturer, extending over more than twenty-five years, has afforded me many opportunities of studying the practical results produced at the blast-furnace. More recently, mere observation of the process of smelting has been supplemented by experimental research, the first fruits of which were communicated (by desire of the Chemical Society) in a paper to be found in their *Transactions* for May, 1869. Since that period, more extensive investigation has somewhat modified the opinions expressed in my communication to that body, and has added to the information previously possessed. To some extent, my views, in respect to the consumption of fuel in iron-smelting, as affected by the size of the blast-furnace and the temperature of the air, have been submitted to the criticism of the members of the Society of Mechanical Engineers and of the Iron and Steel Institute, and the results may be found in the *Proceedings* of these two Associations. In the meantime the performance of a number of furnaces of different constructions, and using different materials, has been carefully studied on the spot, a task which I have been able to perform by permission, most readily granted, of esteemed colleagues in the iron trade. The experience thus obtained opened out an extensive field of enquiry for the chemical laboratory, involving the performance of many experiments requiring great delicacy of manipulation. To assist me in these, I have had the advantage of the co-operation of Mr. C. R. A. Wright, D.Sc., who has bestowed the greatest care in carrying out my wishes in connection with a somewhat prolonged and laborious investigation, recorded in these pages under the following headings of sections:—Formation of Carbonic Oxide in the Blast-Furnace; Action of Carbonic Oxide on Iron Ore in the Blast-Furnace; Experiments to Ascertain the Temperature at which Carbonic Oxide commences to Act on Oxide of Iron; Behaviour of Oxide of Iron in contact with Carbonic Oxide at a Red Heat; Action of Carbonic Oxide on Metallic Iron; Action of Mixtures of CO and CO_2 on Fe; Action of Mixtures of CO and CO_2 on Fe_2O_3; Action of Gases of Blast-Furnace on Oxide of Iron; Reducing Effects of Gases at Different Depths of the Blast-Furnace; Dissociation of Carbonic Oxide in the Blast-Furnace; Circumstances which Limit Carbon Deposition; Carbon Deposition as effected by the Blast-Furnace; Change experienced by Metallic Iron and by Iron Oxides which have served to Dissociate CO (heat alone does not suffice for dissociating CO in the blast-furnace); Effect of certain Metallic Substances, besides Iron, on Carbonic Oxide, including Silicon; Summary of Action of CO and CO_2 on Metals and their Oxides, including Silicon; Deposited Carbon, the supposed Partial Cause of certain Apparent Anomalies in the Composition of Blast-Furnace Gases; Office Performed by Deposited Carbon; Generation and Behaviour of CO_2 in the Blast-Furnace; on Hydrogen, its Source and possible Influence in the Blast-Furnace; on Ammonia in the Blast-Furnace; on Hydrocarbons in the Blast-Furnace; on the Presence of the Metallic Bases of the Fixed Alkalies in the Gases of the Blast-Furnace; on the Presence of Alkaline Cyanides in the Blast-Furnace; 'Fume' Emitted by the Blast-Furnace; Estimate of the Quantity of Heat required in the Process of Iron Smelting."

It is evident from the above that this work is not simply intended for the metallurgist, but treats thoroughly of the chemistry of the blast-furnace, as investigated experimentally in all its bearings and relations by no less than some 515 experiments. These are described in minute detail, and are valuable also as a contribution to our knowledge of the action of bodies upon each other at high temperatures. The whole research is a pattern of good and refined methods of analysis, requiring philosophical skill in conception, as well as great dexterity of manipulation. We shall lay before our readers extracts from this work at an early date.

Year-Book of Pharmacy; comprising Abstracts of Papers relating to Pharmacy, Materia Medica, Therapeutics, and Chemistry contributed to British and Foreign Journals from July 1st, 1869, to June 30th, 1870. With the Proceedings of the British Pharmaceutical Conference at the seventh annual meeting, held at Liverpool, September, 1870. London: J. Churchill and Sons. 1870.

The title of this book indicates the contents we may expect to find in it, and we therefore welcome the volume with pleasure, because it inaugurates a new era in this country for that branch of the practice of medicine usually called pharmacy. The work is highly creditable to its authors, and contains the following matter:— A preface, extremely well written and to the point; weights and measures—most useful, complete, and carefully made up; American pharmacy; American elegant pharmacy and American recipes; English and Continental pharmacy; materia medica; chemistry—notation and nomenclature; physiological and pathological chemistry; chemical analysis—manipulation and apparatus; modern chemical theory, by Dr. Debus; notes; societies and institutions; personal notices; bibliography; unclassified memoranda; proceedings of the British Pharmaceutical Conference, Liverpool; pharmaceutical exhibition; century of old books. This last chapter is by no means the least interesting portion of this volume, and is a novelty which deserves imitation; one hundred volumes are included in this collection, those only being noticed of special interest. Space forbids us to enter here into more extensive details on the contents of this interesting and well got up work, which proves that the pharmacists of this country are becoming more and more what they should be—men of scientific education and of general learning.

CORRESPONDENCE.

JOULE AND SCORESBY'S EXPERIMENTS ON THE MECHANICAL POWERS OF ELECTRO-MAGNETISM, STEAM, AND HORSES.

To the Editor of the Chemical News.

Sir,—I was rather startled some weeks ago by the perusal, in the Chemical News of January 27th (vol. xxiii., p. 42), of the Rev. H. Highton's examination of Joule and Scoresby's experiments on the mechanical powers of electro-magnetism, &c.

The idea soon presented itself to my mind that, if the writer had thoroughly comprehended their experiments and formulæ, he could not have made such rash assertions as are found in his communication. Since then I have carefully read the account of the researches on which he comments, as given in the *Philosophical Magazine* (3), xxviii., and I hope to be able to point out where the reverend gentleman is at fault.

In the first place, he says that he cannot understand why Joule and Scoresby introduced the assumption, that the heat evolved in the circuit is directly proportional to the squares of the intensities of the currents when the engine is at rest; and when it does work, alleging that no use is afterwards made of this assumption. He then accuses these eminent physicists of having framed their formula on a perfectly different and contradictory hypothesis—viz., that the heat produced in the two cases just mentioned is directly proportional to the intensities of the currents, or the quantities of zinc consumed. If he had said, and understood, that the heat evolved per "*given quantity*" of zinc consumed was directly proportional to the intensities, he would have been quite correct, and would probably have avoided the subsequent errors into which he has fallen.

This matter, which would seem to have puzzled Mr. Highton, appears to me sufficiently simple, and to admit of easy explanation.

Let us call the heat evolved in the two cases H and H', the intensities of the currents a and b, and the quantities of zinc consumed Z and Z'. We will have, as found by Joule, $H : H' :: a^2 : b^2$, also $Z : Z' :: a : b$; therefore by division—

$$\frac{H}{Z} : \frac{H'}{Z'} :: a : b.$$

That is to say, the heat evolved per grain of zinc when the engine is at rest : the heat evolved per grain of zinc when the engine is doing work $:: a : b$. $a - b$ will therefore represent the quantity of heat per grain of zinc converted into useful mechanical power. But Joule has shown that, if the whole heat developed by the consumption of 1 grain of zinc in a Daniell's battery could be converted into useful mechanical power, it would be equal to 158 foot-lbs. We therefore obtain the value of x, on the economical duty of 1 grain of zinc, by the following proportion:—

$$a : a - b :: 158 : x$$
$$x = \frac{(a-b)\ 158}{a}$$

I trust that this will be sufficient to convince the Rev. H. Highton that the assumption $H : H' :: a^2 : b^2$, is not an irrelevant statement of M. Joule's, but is, in fact, the fundamental principle on which the formula is based.

It is evident, from inspection of this formula, that when b vanishes, or becomes infinitesimally small, x, or the economical duty, is a maximum; but Mr. Highton says that it is certainly a most startling result that the maximum of work should be done when no zinc at all is consumed.

Surely he cannot have a very clear idea of the meaning of the phrase "economical duty." When b becomes infinitesimally small, the amount of work done by the engine is certainly very small also: but x, or the amount of heat converted into mechanical power per grain of zinc, is, nevertheless, a maximum.

Your correspondent, in his criticism, goes on to say that Joule and Scoresby framed their equation on the assumption that the battery produced the same amount of heat whatever was the quantity of zinc consumed. He then remarks, very logically, that when the consumption of zinc fell from 500 to 200 grains per hour, the difference of heat corresponding to these two quantities could not disappear, because it never was produced at all. Mr. Highton should have known that $a - b$ represents the difference of heat evolved per grain of zinc, and not, as he supposed, the difference between the total amounts of heat produced by the battery in each case, which would be represented by $a^2 - b^2$.

Having thus pointed out, I hope clearly, where Mr. Highton seems to me to have gone astray—I am, &c.,

Richard Apjohn.

South Hill, Black Rock,
February 27th, 1871.

WOOD DISTILLING.

To the Editor of the Chemical News.

Sir,—I notice, by your report of my account of wood-distilling read before the Chemical Society on the 16th inst., that I have, by a strange oversight, given an incorrect account of the gases produced. I have omitted all mention of hydrogen, I suppose, because I took it for granted that it was there, and known to be there by all chemists. Not only is it present, but it constitutes a very large part of the gas, and may almost be said to be its most important constituent.—I am, &c.,

Ernest T. Chapman.

February 27th, 1871.

HYDRATE OF CHLORAL.

To the Editor of the Chemical News.

Sir,—Whenever a new chemical agent is introduced by the medical profession, the manufacturer of the preparation must be grateful to the scientific chemist for pointing out any defect or inferiority in the quality of the article. Never, perhaps, was this more clearly the case than with the introduction of chloral hydrate; because of its decided action upon the human system demanding an almost absolute purity, and because of the astonishing rapidity with which it has found favour. This compound, discovered nearly forty years ago by Professor Liebig, remained a chemical curiosity until within the last two years. Its medicinal value was first ascertained by Dr. Liebreich; and to-day it is manufactured and sold by the hundredweight as an ordinary article of commerce. Nearly the whole, if not the whole, quantity used in this country is imported from Germany.

We happen to represent one of the largest manufacturers in Germany, Messrs. E. de Haen and Co., of Hanover, and we were much pleased on first seeing a paper on chloral hydrate reprinted in the *Pharmaceutical Journal* of the 7th ult., giving analyses of samples representing seven or eight different firms, including Messrs. De Haen and Co.; but, on reading the paper, we were much disappointed in finding that the writer, a Mr. M——, of Liverpool, had penned the article in ignorance of the matter he was treating.

He stated, as the result of his analyses, that the samples of only one house were good chloral hydrate, yielding, on decomposition by ammonia, very nearly the theoretical proportion of chloroform (72·2 per cent); whereas all the other samples were said to have yielded so little chloroform (varying from 53·6 to 56·6 per cent), that the reader was led to draw the inference that they were not chloral hydrate, but chloral alcoholate. Two of these samples were marked as De Haen and Co.'s manufacture; and, as we had no doubt about the inaccuracy of the above statement, we placed our stock at Dr. Versmann's disposal, who, from samples taken by himself, found them to be good marketable chloral hydrate, perfectly free from alcoholate. His report and analysis is published in full in the *Pharmaceutical Journal* of the 4th inst.

On applying to Mr. M—— for an apology for the injury done, he confessed that one sample named as Messrs. De Haen and Co.'s was from another house; and, as he had part of the original samples left, he suggested to send them to a chemist to act as referee, proposing, at the same time, Dr. Benjamin Paul, an offer we cheerfully accepted.

Dr. Paul's analysis, as below, proved Mr. M——'s figures to be totally wrong. As no doubt a great many of the readers of the Chemical News, have seen the paper, and may possibly have believed Mr. M——'s assertions, we feel it our duty, in justice both to the house we represent and to ourselves, not only to publicly contradict the same, but to prove them utterly groundless, and for this reason we request the favour of your inserting this letter in your journal. In conclusion, we may say—

(1). That chloral hydrate is extremely hygroscopic, which satisfactorily accounts for the somewhat smaller numbers found by Dr. Paul. The samples received by him were several months old, and were no doubt repeatedly exposed to the air, thereby taking up moisture. If kept in well-stoppered bottles, they certainly would have given the proper percentage of chloroform.

(2). That the much greater yield of the sample stated to be E. De Haen and Co.'s when analysed by Dr. Paul, and the smaller yield of the manufacture stated to be Liebreich's, in comparison to Mr. M——'s analysis, shows that the analysis of manufactures of all good makers gives about the same results; but the ammonia test for chloral hydrate, simple as it is—and, in fact, any analysis laying claim to correctness, ought only to be published after several trials of one and the same sample—carefully and scientifically made, shows the same result.

(3). That, before publicly comparing the products of respectable houses, particularly when a new article is in question, application for information ought to be made to them; the same will always most readily be given by them.

Results of Analyses of Chloral Hydrate.

		Dr. Benjamin Paul.	Mr. M——, Liverpool.
No. 1. }	Stated to be Liebreich's {	66·62	71·5
No. 3. }		67·36	70·3
No. 8.	„ „ De Haen's	64·37	55·6

—We are, &c.,

Domrier & Co.

47, Basinghall Street, London, E.C.,
February 22nd, 1871.

[We have also received from Messrs. H. and Geo. Schœttensack a letter saying that the paper by Mr. A. H. Mason is calculated to do them serious injury; they enclose the results of an analysis of their chloral hydrate by Mr. K. Müller, and a certificate of Professor F. Wöhler, which prove the purity of their preparation. We shall return to this communication shortly.—*Ed.* C. N.]

MISCELLANEOUS.

Victims of the War.—According to notes by Mr. Thomas Suttton in the *British Journal of Photography*, we learn that M. Thénard, whose name has often appeared in our pages, is now a prisoner in Germany. He was taken from his peaceful pursuits in his laboratory as a hostage, after having been twice heavily requisitioned. The young artist, M. Regnault, son of the distinguished chemist, having joined the Paris army was killed in the last sortie. He had pinned to the lining of his coat a card bearing the name and address of his *fiancée*, with a request that if he fell she might be immediately informed of the circumstance.

Chemical Society.—The following is the Council's list for the election of officers on March 30th, 1871:—President—E. Frankland, D.C.L., F.R.S. Vice-Presidents who have filled the office of President—Sir B. C. Brodie, F.R.S.; Warren De la Rue, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; Lyon Playfair, M.P., Ph.D., C.B., F.R.S.; A. W. Williamson, Ph.D., F.R.S.; Col. P. Yorke, F.R.S. Vice-Presidents—H. Debus, Ph.D., F.R.S.; J. H. Gilbert, Ph.D., F.R.S.; H. M. Noad, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; T. Redwood, Ph.D.; J. Stenhouse, Ph.D., F.R.S. Secretaries—A. Vernon Harcourt, M.A., F.R.S.; W. H. Perkin, F.R.S. Foreign Secretary—H. Müller, Ph.D., F.R.S. Treasurer—F. A. Abel, F.R.S. Other Members of the Council—E. Atkinson, Ph.D.; H. Bassett; C. L. Bloxam; A. Dupré, Ph.D.; F. Field, F.R.S.; Dr. M. Holzmann; E. J. Mills, D.Sc.; ; H. McLeod; W. J. Russell, Ph.D.; H. E. Roscoe, Ph.D., F.R.S.; R. Angus Smith, Ph.D., F.R.S.; A. Voelcker, Ph.D.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

The American Journal of Science and Arts, February, 1871.

This number contains the following original papers and memoirs relating to chemistry and physical sciences:—

Observations on the Variation of the Magnetic Declination in connection with the Aurora of October 14th, 1870; with Remarks on the Physical Connection between Changes in Area of Disturbed Solar Surface and Magnetic Perturbations.—Dr. A. M. Mayer.—This paper contains, beside diagrams, a series of results of observations embodied in a tabulated form; but the contents, however valuable, are not well suited for abstraction.

Notes on Granitic Rocks.—Dr. T. Sterry Hunt.—The first portion of a monograph containing the following sections:—Definitions of granite and syenite; structure of granitic and gneissic rocks; felsites and felsite-porphyries; gneisses and granites of New England; granitic dykes and granitic vein-stones; Scheerer's theory of granitic veins; Elie de Beaumont on granites and granitic emanations; granitic distinguished from concretionary veins; Von Cotta on granitic veins; the author's views on the concretionary origin of granitic veins; the banded structure of granitic veins.

Lower Carboniferous Limestone in Ohio.—Professor E. B. Andrews.—A paper the contents of which, bearing upon paleontology, are chiefly of local interest.

Existence of the Nummulitic Formation in China.—Baron von Richtenhofen.—A contribution to our knowledge of the geology of the Chinese Empire.

Aurora Belt of October 24—25, 1870.—An account of the phenomenon alluded to as observed in a portion of the territory of the United States.

Postscript.—A loose half-page containing extracts from letters giving information respecting the observations on the eclipse of the sun December 22nd last, made in Sicily.

Polytechnisches Journal von Dingler, second number for December, 1870.

This number contains the following original papers relating to chemistry and allied subjects:—.

Steam Turbine for Imparting Motion to Stirring and Grinding Apparatus intended for Chemical Purposes.—F. C. Gruner.—The description, illustrated by a woodcut, of a simple, effective, and, moreover, cheap apparatus, which may be very useful to pharmaceutical and manufacturing chemists and large chemical laboratories.

Galvanic Battery.—W. Beek.—The description, illustrated by engravings, of an apparatus always ready for use for lecture experiments.

Photometrical Researches on a Uniform Unit of the Measurement of Light.—S. Elster.—This lengthy essay, accompanied by a series of engravings, contains the following sections:—Arrangement for fixing the normal illuminating power of the experimental candles; arrangement for fixing the maximum illuminating power of gas.

Notice on M. Steinmann's Lime-Kiln Heated with Gas.—Dr. O. von Tech.—Illustrated with engravings. It appears that, for equal weights of lime obtained, the heating of the kilns with gas, according to M. Steinmann's plan, effects a saving of fully 50 per cent of the cost of fuel, while the lime is a more valuable article, on account of its greater purity and freedom from contamination with ash.

Action of the Magnesia during the Hardening of the Lime-Alumina Silicates under Water.—Dr. C. Bender.—The main results, obtained by a series of experiments, of which the author gives an account in this memoir are, that magnesian limestones, even when so burnt as to convert the smallest possible quantity of carbonate of lime into lime, do not thereby become good hydraulic limes, while the presence of a large quantity of magnesia in lime-alumina silicates, even when burnt with care, impairs the hardening of these substances; while, if the burning of these materials is carried out to the extent of sintering (semi-fusing) the same, it appears that a portion of the lime remains uncombined with the silica, and as a consequence the mortar made with this substance crumbles to powder when under water.

Imparting of a Yellowish Hue to White Marbles.—R. Weber.—This lengthy essay contains, as chief point of interest, the hitherto unknown fact that alcoholic solutions of perchloride of iron are not precipitated by carbonate of lime, and may therefore be applied in different degrees of concentration to impart a more or less deep yellow hue to white marble.

Spectrum Analysis of Fatty Oils.—Dr. J. Müller.—A paper illustrated by a woodcut, and giving an account of the spectra exhibited by various samples of fixed or fatty oils.

Alloy suited for Soldering Steel and Iron to Brass.—Dr. E. Dingler.—Three parts of tin, 39½ of copper, and 7½ of zinc. It is stated that, by this alloy in molten state, steel and iron, as well as these and brass, can be so joined together as to prevent any breakage.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, July, 1870.

This number had not been forwarded at the time of its publication; it contains the following original papers relating to chemistry:—

Officinal Phosphoric Acid, and Detection of Phosphorous Acid in the same.—Dr. Reickher.—This lengthy essay treats on the preparation of phosphoric acid by the oxidation of phosphorus by means of nitric acid, and on the detection of phosphorous acid in the resulting product. As regards the proportions of nitric acid and phosphorus, the author thinks that 14 parts of the former to 1 part of the latter are required. The reagent employed for detecting the presence of phosphorous acid is mercuric chloride (corrosive sublimate) in slight excess, and application of heat to about 80°.

Chemical Analysis of the Mineral Water of Ochsenhausen (Wurtemberg).—O. A. Biberach.—One hundred thousand grammes of this water contain the following substances, in quantities of grms.:—Silica, 1·4; carbonate of lime, 13·08; carbonate of magnesia, 4·162; chloride of potassium, 5·221; sulphate of potassa, 4·187; nitrate of potassa, 5·736; carbonate of soda, 4·212; carbonate of protoxide of iron, 0·26; semi-combined carbonic acid, 9·791; free carbonic acid, 3·675;—total of solid and volatile (gaseous) constituents, 51·726.

Java Cinchona Barks, and the Quantity of Alkaloids therein Contained.—J. Jobst.—A lengthy memoir containing a detailed pharmacologico-chemical account of researches made on a series of samples of cinchona bark imported from Java.

October, 1870.

This number contains the following original papers relating to chemistry:—

Sulphovinate of Soda.—Th. Diez.—The author prepares this salt, which is now medicinally employed, by first mixing 12 ounces of pure (free from arsenic) and concentrated sulphuric acid with 8 ounces of pure alcohol (sp. gr. 0·825 = 97·6 per cent). The acid is poured into the alcohol, so as to cause a considerable elevation of the temperature of the mixture, but without causing it to become deeply coloured. After having been left standing for several hours, water is added, and next carbonate of baryta (artificial is to be preferred). The sulphate of baryta having been removed, the solution containing sulphovinate of baryta is moderately heated, and then treated with a solution of pure carbonate of soda in water, until a slightly alkaline reaction is obtained. The solution is next filtered for the removal of the carbonate of baryta, and the filtrate evaporated upon a water-bath until a dry powder is obtained. The sulphovinate of soda—

$$(2SO_2,C_4H_4O,NaO+HO),$$

is capable of crystallisation, but the salt is extremely deliquescent. Genuine sulphovinate of soda, free from any carbonate of soda, is not acted upon by baryta solutions unless heat be applied. If the dry sulphovinate of soda is mixed with dry acetate of potassa, and the mixture heated in a test-tube, acetic ether is given off, which reaction is a characteristic test for the sulphovinate. This on being taken internally, becomes decomposed by the action of the acid in the stomach, and converted slowly into alcohol and sulphate of soda, thus yielding a laxative medicine with a counter-agent to its too great debilitating action.

November and December (double number), 1870.

Contains the following original papers relating to chemistry:—

Materials Suitable for the Manufacture of Cements.—Dr. C. Bender.—The continuation and conclusion of a very lengthy memoir on this subject.

Hydrochloric Acid as the Basis of Alkalimetry.—Dr. Græger.—Reserved for full translation.

Soup Tablets.—H. Reinsch.—Take 11 parts, by weight, of good suet, melt it in an iron pan, and make it very hot (brown it); add, while keeping the fat stirred, 18 parts of rye meal, and continue heating so as to make the mass (constantly stirring it) brown; add then 4 parts of dried salt and 2 parts of coarsely-pulverised carraway. The mixture is then poured into tins somewhat like those used for making chocolate into cakes. The cakes have the appearance of chocolate, and are chiefly intended for the use of soldiers while in the field. A quantity of about 33·5 grms. of this preparation is sufficient to yield, when boiled with some water, a portion of good soup, and, in case of need, the cakes, being agreeable to the taste, may be eaten raw.

Chemical Composition of Edible Mushrooms.—Dr. O. Siegel.—*Boletus edulis, L.*, contains, in fresh state—Water, 15·42 per cent; dry matter, 84·52 per cent; 100 parts of which consist of—Proteine compounds, 22·82; mannite, 5·84; fat, 1·98; extractive matter, 57·29; woody fibre, 6·55; ash, 6·22, containing, in 100 parts, 20·12 of phosphoric acid and 50·95 of potassa. *Cantharellus cibarius* contains in fresh state, 92·08 per cent of water, and when air dry, 16·48 per cent. 100 parts of the dry substance contain—Proteine compounds, 23·43; fat, 1·38; extractive matter, 46·85; woody fibre, 9·47; ash, 8·19, containing, in 100 parts, 31·32 of phosphoric acid and 48·75 of potassa, *Clavaria flava* contains, in fresh state, 21·43 per cent of water. 100 parts of the dry substance contain—Proteine compounds, 24·43; mannite, 7·81; fat, 2·13; extractive matter, 48·94; woody fibre, 6·94; ash, 9·75, containing, in 100 parts, 35·07 of phosphoric acid and 51·47 of potassa. *Morchella esculenta* contains, in fresh state, 15·82 of water. 100 parts of the dry substance contain—Proteine compounds, 33·90; mannite, 7·48; fat, 1·71; extractive matter, 40·59; woody fibre, 6·58; ash, 9·74, containing, in 100 parts, 37·75 of phosphoric acid and 50·04 of potassa. *Tuber cibarium* contains, in fresh state, 70·83 per cent of water. 100 parts of the dry substance contain—Proteine compounds, 36·32; fat, 2·48; extractive matter, 23·16; woody fibre, 28·31; ash, 9·73, containing, in 100 parts, 30·85 of phosphoric acid and 55·97 of potassa.

Annalen der Physik und Chemie, von Poggendorff, No. 12, 1870.

This number contains the following original papers and essays:—

Elasticity of Iron, Copper, and Brass, especially in reference to Temperature.—F. Kohlrausch and F. E. Loomis.—This lengthy essay, illustrated by woodcuts and engravings, contains the following sections:—Description of apparatus and mode of observation; reduction of observations; calculation of the co-efficients of temperature; temperature and modulus of elasticity of iron, copper, and brass; absolute moduli of elasticity of iron, copper, and brass wires, as determined by the aid of torsion oscillations and velocity of sound.

Relation Existing between Meteorites and Stones (Rocks) met with on our Globe.—Dr. C. Rammelsberg.—A review of a paper published in the *Comptes Rendus*, vol. lxii. (1866), by M. Daubrée, under the title "Expériences Synthétiques Relatives aux Météorites; Rapprochements aux quels ces Experiences Conduisent, taut pour la Formation de ces Corps que pour celle du Globe Terrestre."

Olivine Rock occurring at Dreiser Weiher (a Mountain of the Eifel Range, Prussia).—Dr. C. Rammelsberg.—This extensive monograph contains a comparative description of a series of minerals—viz., olivine, broncite, diopside, chrome-iron ore. The olivine rock alluded to consists of 68·50 per cent of matter soluble in hydrochloric acid, consisting of—Silica, 27·41; magnesia, 34·24; protoxide of iron, 6·85; and of 29·69 of matter insoluble in hydrochloric acid, consisting of—Silica, 15·57; alumina, 1·74; magnesia, 8·35; lime, 2·29; protoxide of iron, 1·74; and a trace of chromium.

New Sulpho-Salts.—R. Schneider.—The fifth portion of a lengthy essay on this subject. Sodium-sulpho palladate and disulphide of palladium, Na_2S,PdS_2 (equivalent=248·6), contains, in 100 parts—Na_2, 18·50; Pd, 42·88; S_2, 38·62. Silver-sulpho palladate, Ag_4PdS_2 (equivalent=418·6), contains, in 100 parts—Ag_2, 51·60; Pd, 25·46; S_2, 22·94. Potassium-palladium-sulpho palladate and semi-sulphide of palladium, $K_2Pd_2S_4$ (equivalent = 526·06), in 100 parts—K_2, 14·87; Pd_2, 60·80; S_4, 24·33.

Determination of the Ratio of the Specific Heat of the Air.—Dr. C. W. Röntgen.—An excellent monograph on this subject, illustrated with engravings, but not suited for useful abstraction.

Measurement of the Intensity of Sound.—A. Heller.—An algebraico-physical treatise illustrated by engravings.

Spectrum of the Aurora Borealis.—F. Zöllner.—Illustrated by woodcuts.

Deduction of the Fundamental Equations of Capillarity from the Principle of Virtual Velocities.—L. Boltzmann.

Observations on the Paper published by MM. Bettendorff and vom Rath "On the Combinations of Sulphur with Selenium."—B. Rathke.

Fusion of Leaden Balls and Leaden Shot when Coming into Contact with an Iron Target.—J. Bodynski.—This paper contains a critical review on a paper published on the above-named subject by Dr. E. Hagenbach.

Review on a Paper published by Dr. Feddersen in vol. cxxxix., p. 639, of the above-named periodical.—K. W. Knockenhauer.—Since the number of this periodical above quoted belongs to vol. cxli., and since the title of Dr. Feddersen's paper is not given, it is scarcely possible to make any abstract of this memoir.

Appendix to a Treatise on the Minimum Deviation of a Ray of Light through Symmetrically-Arranged Prisms.—R. Most.

Apparatus for Analytico-Synthetic Composition of Mixed Colours.—E. Ketteler.—Illustrated with woodcuts.

Observations on Molecular-Statistical Aphorism, as set forth by M. Lüdtge.—Dr. G. van der Mensbrugge.

An Experiment with Small Shot.—E. Reusch.—This paper, illustrated with a woodcut, contains a discussion on the forces at play when a small pair of forceps holds 2 grains of small shot.

Observations on the Researches of Dr. Andrews on the Compressibility of Carbonic Acid.—D. Mendelejeff.

NOTES AND QUERIES.

Tattooed Marks.—Is it possible to erase them? If so, what are the safest means for erasing them from the hand, without injury to it afterwards?—SCOTIA.

Testing Gold.—(Reply to "Inquirer.")—Obtain a touch-stone and touch-needles, as they are called, being small pieces of gold variously alloyed, and used to compare, on the stone, the streak they make with that given by articles of jewellery, while at the same time a nitric acid of proper strength is used to detect baser metals.

Tar Distilling.—(Reply to "Tar Distiller.")—It appears from your account that you work from the first with fire, instead of by heating with coils of pipes inside the still, through which high-pressure steam is made to pass. The boiling over is due, in all likelihood, to the mode of setting the stills in the furnace, whereby too much heat is imparted to the bottom of the still, and a sudden formation of vapours there causes the thickish fluid to boil over.

Manufacture of Alcohol.—Reply to R. Fisher.)—You may not manufacture alcohol from malt grain, nor distil, unless you take ou tthe necessary licenses and place your premises under the constant supervision of the Excise and Inland Revenue officers; for any infringement of these regulations you will become liable to heavy fines, confiscation of apparatus, and even imprisonment.

Lute for Corks, &c.—It may be of interest to some of your readers to know that anthracene acts capitally as a substitute for paraffin (either by itself, or mixed with the latter) in covering corks or joints of apparatus requiring to stand a comparatively high temperature. A luting of anthracene is capable of standing a high pressure and temperature combined for a lengthened period.—ROBERT F. SMITH.

Chemical Agriculture and Manufacture of Sugar.—(Reply to J. T.)—"The Nature and Properties of the Sugar Cane, with Practical Directions for the Improvement of its Culture and the Manufacture of its Products," by George R. Porter, F.R.S.; second edition; London: Smith, Elder, and Co.; 1843. "The Practical Sugar Planter, a Complete Account of the Cultivation and Manufacture of the Sugar Cane, &c.," by L. Wray; London: Smith, Elder, and Co.; 1848 (2 vols.). "Lectures on Agricultural Chemistry and Geology," by James F. W. Johnston, M.A., &c.; second edition; W. Blackwood and Sons, Edinburgh and London. "Principles of Agriculture," by Albert D. Thaër; translated by W. Shaw; 2 vols.; London: Ridgway; 1844. "Traité des Arts Céramiques," par A. Brongniart; 2 vols. and atlas, with plates; Paris; 1844 (Béchet Jeune, editeur). "Chefs-Dœuvres of the Industrial Arts," by Phillippe Burty; edited by W. Chaffers; London: Chapman and Hall; 1869.

MEETINGS FOR THE WEEK.

MONDAY, March 6th.—Medical, 8.
—— Royal Institution, 2. General Monthly Meeting.
—— London Institution, 4. Mr. R. A. Proctor, M.A., F.R.A.S., "On Astronomy."
TUESDAY, 7th.—Royal Institution, 3. Dr. Foster, "On Nutrition."
—— Civil Engineers, 8.
—— Ethnological, 8.
—— Zoological, 8.
WEDNESDAY, 8th.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 9th.—Royal, 8.30.
—— Royal Institution, 9. Dr. Odling, "On Davy's Discoveries."
—— London Institution, 7.30. Prof. J. C. Thorold Rogers, "On the Colonial Question."
—— Royal Society Club, 6.
FRIDAY, 10th.—Royal Institution, 9. Dr. W. B. Carpenter, F.R.S., &c., "On the latest Scientific Researches in the Mediterranean and Straits of Gibraltar."
—— Quekett Microscopical Club, 8.
SATURDAY, 11th.—Royal Institution, 3. Mr O'Neil, "On the Spirit of the Age."

TO CORRESPONDENTS.

C. R. C. Tichborne.—We shall feel obliged if you will continue to send the journal to the same address.

J. Wallace Young.—The paper arrived too late for insertion this week.

R. Apjohn.—Received.

A. H. Allen.—Received with thanks.

X. Y. S.—A few copies of the "Cattle Plague Report," by the Editor, still remain on hand; one will be forwarded on your sending thirteen stamps to our publisher.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 589.

ON THE EFFECT OF COLD ON THE STRENGTH OF IRON.*

By PETER SPENCE, F.C.S., &c.

IN the conversation at the last meeting of the Society on one of the causes of railway accidents, namely, the breaking of the tires of the carriage wheels, there was a general expression of opinion that the reduction of temperature during frost had the effect of reducing the strength of iron, and that this was the proximate cause of these occurrences. Dr. Joule, on the other side, stated that, however general the impression might be, he knew of no experiments that tended to prove that impression to be a correct one.

It seemed to me that a few experiments on cast-iron could without much difficulty be made, and which might set the matter at rest one way or the other.

I therefore decided on having some lengths of cast-iron made of a uniform thickness of ½ inch square, from the same metal and the same mould; these I obtained after a good deal of trouble, on account of the moulders being off work at new year's time, and this must be my excuse for not being able to give due notice of my communication.

Two of the four castings I got seemed to be good ones, and I got the surface taken off, and made them as regular a thickness as was practicable.

I then fixed two knife-edged wedges upon the surface of a plank, at exactly nine inches distance from each other, with an opening in the plank in the intervening space; the bar being laid across the wedges a knife-edged hook was hung in the middle of the suspended piece of the bar; to the hook was hung a large scale on which to place weights.

The bar was first tried at a temperature of 60° F.; to find the breaking weight I placed 56-lb. weights one after another on the scale, and when the ninth was put on the bar snapped. This was the only unsatisfactory experiment, as 14 or 28 lbs. might have done it, but I include it among the others. I now adopted another precaution, by placing the one end of the plank on a fixed point and the other end on to a screw-jack, by raising which I could, without any vibration, bring the weight to bear upon the bar. By this means, small weights, up to 7 lbs. could be put on while hanging, but when these had to be taken off and a large weight put on, the scale was lowered to the rest, and again raised after the change was made. I may here state that a curious circumstance occurred twice, which seems to indicate that mere raising of the weight, without the slightest apparent vibration, was equal in effect to an additional weight. 3¾ cwts. were on the scale, a 14-lb. weight was added, then 7 lb., then 4 lbs., 2 lbs., 1 lb., making 4 cwts. and 1 lb. This was allowed to act for from one to two minutes, and then lowered to take off the small weights, and replaced by a 56 lb., intending to add small weights when suspended, raised so imperceptibly by the screw, that the only way of ascertaining that it was suspended was by looking under the scale to see that it was clear of the rest. As soon as it was half an inch clear it snapped, thus breaking at once with one pound less than it resisted for nearly two minutes.

Six experiments were carefully conducted at 60° F. the parts of the bars being selected so as to give to each set of experiments similar portions of both bars: the results are marked on the pieces. My assistant now prepared a refrigerating mixture which stood at zero, and the bars were immersed for some time in this, and we prepared for the breaking trials to be made as quickly as could be, consistently with accuracy; and to secure the low temperature each bar on being placed in the machine had its surface at top covered with the freezing mixture. The bars at zero broke with more regularity than at 60°, but instead of the results confirming the general impression as to cold rendering iron more brittle, they are calculated to substantiate an exactly opposite idea, namely, that reduction of temperature *cæteris paribus* increases the strength of cast-iron. The only doubtful experiment of the whole twelve is the first, and as it stands much the highest, the probability is that it should be lower; yet, even taking it as it stands, the average of the six experiments at 60° F., gives 4 cwts. 4 lbs. as the breaking weight of the bar at that temperature, while the average of the six experiments at zero gives 4 cwts. 20 lbs. as the breaking weight of the bar at zero, being an increase of strength from the reduction of temperature equal to 3·5 per cent.

In the discussion which followed the reading of this paper Mr. W. Radford, C.E., asked if Mr. Brockbank had considered what the effect must be upon iron used in Russia, Sweden, Norway, and Denmark, for if the theory which was sought to be established were true, the tires of railway wheels in those countries must fly to pieces in winter; as far as his experience went in Denmark such had not been the case on the Copenhagen Railway.

* Read before the Manchester Literary and Philosophical Society.

ON THE PHOSPHATE PROCESS FOR THE UTILISATION OF SEWAGE,

AS APPLIED TO SEWAGE IRRIGATION AND TO THE PURIFICATION OF SEWAGE BY PRECIPITATION.

By DAVID FORBES, F.R.S., &c.

THE subject of the disposal of the sewage of towns is now recognised as one of the great sanitary problems of the age, and admitted to be of vital importance, not only to the welfare of the inhabitants, but also to the country at large. The very difficulties, however, which are connected with its consideration have apparently been the principal reasons why, until comparatively lately, this subject has been so little studied, and if not altogether neglected, at least treated in a sort of makeshift way, until the evil effects of such indifference have made themselves felt to such an extent that its mature consideration can no longer be evaded.

If the subject of sewage utilisation be considered merely from a purely agricultural point of view, it is self-evident that the direct application to the soil of what may be called the original unadulterated excreta, both solid and liquid, must be the most advantageous of all systems for their disposal and utilisation.

In towns, however, and more particularly in large ones, the imperative necessity for the instant removal of matter which every moment is becoming more and more offensive and injurious in a sanitary point of view, combined with the difficulty and inconvenience arising from its direct collection and conveyance to the land, are so great as to have resulted in the all but universal adoption of the closet system, in which water is employed as a medium for its transport into and along the sewers, to such a distance as may be considered beyond the limits within which its further decomposition could give rise to discomfort and disease.

When, however, this had been accomplished, the question still remained to be answered, as to what must ultimately be done with the excreta thus enormously diluted, and consequently immensely reduced in agricultural

value; the more so from their having received, in their transit so far, the addition of the rainfall and surface-dirt, and the admixture of the waste products of manufactories, which in themselves are not only valueless, but too often even highly injurious to either animal or vegetable life.

The ancient time-honoured, but barbarous system, unfortunately too often followed, even in the present day—that of turning the filthy sewage into the nearest watercourse or river—can no longer be tolerated in these days of advanced civilisation, when we have at length become convinced that by these means our streams have in many instances already become so polluted, that they can no longer furnish water fit for either man or beast to drink, or fishes to live in, besides having our river beds silted up by deposits of fœtid mud, and where, in the more thickly populated districts, we witness rivers which we remember to have once been clear and pure, now actually converted into so many open sewers, exposing a large surface of putrid liquid to taint the surrounding atmosphere and impair the health of those dwelling in the vicinity; whilst, at the same time, they carry down with them into the sea whatever agricultural value is represented by the excreta, to the loss of the country, which must pay for foreign guano and other fertilising substances to replace it.

It is no wonder, therefore, that attention has of late years been directed to the devising of means for effecting the purification of sewage, at least to such a degree that the affluent water may, without injury or offence, be allowed to mix itself with the natural drainage water of the land. Up to the present time, however, no one of the various systems as yet submitted to a practical test, can be said to have given satisfactory results; the experience acquired already has, however, clearly proved that no merely mechanical system of filtration can ever be expected to succeed, and shown that it is absolutely essential that chemical forces also be brought into play in order to effect the desired purification.

The various modes hitherto adopted for sewage purification, which depend directly or indirectly upon the co-operation of chemical action, may be classed under the two heads of (1) purification by means of irrigation, and (2) purification by the direct chemical treatment of the sewage. Although these two systems have hitherto been too often regarded as altogether antagonistic to one another, the results of the latest inquiries into the subject clearly show that this need not in reality be the case, and indicate that a combination of both these systems promises, in practice, advantages which neither of them, taken singly, can be expected to attain.

The phosphate process for the purification and utilisation of sewage, first brought before the public a few months back, at the Liverpool meeting of the British Association, and which is, it is believed, the first attempt hitherto made to devise a process equally applicable to either sewage irrigation or precipitation, consists in treating the sewage with a solution of the native phosphate of alumina dissolved in sulphuric or hydrochloric acid. This solution is in itself a powerful antiseptic and disinfectant, completely arresting further putrefaction, and depriving the most fœtid sewage of its offensive smell, causing, at the same time, the supernatant water to be clear and colourless, even if tinctorial substances of great intensity be present in the liquid, effects which are mainly due to chemical reactions between the alumina salts and the organic matter in the sewage, by which compounds are formed, especially with the nitrogenous or albumenoid constituents, more or less insoluble in water—a property which has long been known and utilised in the arts of dyeing, the manufacture of pigments and sugar, and the clarification of liquids.

The experiments to illustrate this method for purifying sewage, shown upon a small scale at the Liverpool meeting of the British Association, have since been repeated on the large scale at Tottenham and elsewhere, with the most satisfactory results, and thus enable me to speak with more confidence as to the applicability of this process when employed in connection with either of the two systems for utilising the sewage of towns in general.

I. Sewage Irrigation.

Sewage irrigation is a good example of a true mechanico-chemical system of treatment, since by its employment the soil itself acts mechanically as a filter, whilst the oxidising action of the air and the growth of vegetation bring powerful chemical actions into operation, to decompose and assimilate the organic and other compounds in the sewage which may be valuable as fertilising ingredients.

There can be no question whatever but, that when the local circumstances of climate and soil are favourable to irrigation and the conditions essential to its success properly observed, that sewage irrigation is the most natural and effective system for the utilisation of sewage, since it is only by this means that we can render available the whole of the ammoniacal salts upon which so very much of the fertilising value of sewage depends.

Supposing, however, that sewage irrigation is employed, even under the most favourable local and other circumstances, there is still one feature in the present mode of carrying it out in practice which will no doubt be admitted by any impartial person conversant with the subject to be highly objectionable, and which, no doubt, also, is one of the principal reasons why sewage farming has not, in practice, met with that favour or success which might have been expected from its theoretical consideration. This objection is, that the suspended and most offensive solid matters in the sewage, when pumped up and distributed over the surface of the land along with the liquid, cannot, like the latter, sink into the soil to contribute its share in the development of the plants; but, on the contrary, in great part covers and stops up the pores of their leaves with a slimy film of fœtid matter, which cannot but tend to impede, if not also injure, the growth of vegetation, and, by its further decomposition, to contaminate more or less the surrounding atmosphere. This solid sewage matter never comes at all within reach of the roots of the plants which could assimilate it, and consequently its agricultural value may be put down as lost; for even if it does not do an absolute injury to vegetation, we imagine that no farmer would consider it profitable to put such manure on the top of his growing crops.

On this subject, we have the testimony of Professor Voelcker, who, in the *Journal of the Royal Agricultural Society of England*, vol. vi., states—

"All who are practically acquainted with sewage irrigation are fully aware of the obstacles which the suspended matter in raw sewage interposes to successful irrigation. Clarification, by any good precipitating plan, whilst it only removes a small portion of fertilising matter from the sewage, greatly improves its suitability for irrigating purposes. Experimental sewage farmers, I believe, will bear me out in maintaining that sewage, perfectly clarified, has a greater practical value than it has in the raw state with all the suspended filth in it. . . . Whenever practicable, therefore, clarified and disinfected sewage should not be wasted, but employed for irrigating our fields."

The fact that sewage, notwithstanding that it is comparatively rich in ammoniacal salts, is extremely poor in phosphates, so essential to the growth and cultivation of many of the most important crops, renders sewage irrigation less suited for general farming and restricts its operations to market gardening and the cultivation of green crops such as Italian rye-grass, &c., for immediate consumption.

There is, therefore, every reason for believing that a great improvement would be effected in the present system of sewage irrigation if measures were taken (1) to separate at least the greater part of the suspended substances; (2) to disinfect, or to some degree arrest, the offensive decomposition until the sewage can be absorbed by the soil and thus conveyed to the roots of the plants; and (3) to increase the manurial value of the sewage by the introduction of phosphates into the sewage in such a form as to be at once taken up by the crops.

By the application of the phosphate process these three conditions can be at once secured in the most simple and efficacious manner, as has already been proved on the large scale at the Tottenham Sewage Works, where it was only found necessary to let the required quantity of the phosphate solution flow into the tanks in which the sewage is received at the pumping station, to arrest the decomposition and effect a speedy clarification caused by the immediate precipitation of the matters held in suspension in the sewage as a deposit which, although of no high agricultural value, may still be used with advantage as a solid manure after the supernatant clarified water has been drawn or pumped off and applied for irrigating purposes for which it is now much better suited, owing to the amount of soluble phosphates which it now contains in addition to its other fertilising ingredients.

By this process, therefore, which might, if required, be even carried out in the sewers themselves (for, in point of fact, the phosphate solution may even be employed instead of the more expensive chlorides of soda or lime, permanganate solution, carbolic acid, chloralum, or other disinfectant), an immediate partial purification of the sewage is at once effected, previous to sending the sewage on to the land, thus doing away with its offensive smell, whilst, at the same time, by adding more or less of the phosphate solution, the agricultural value of the irrigating water may be increased to any desired extent, and thus grain or other crops quite unsuited to sewage irrigation, as at present practised, may be grown without any other manure than the sewage water so treated; the supply of phosphates necessary for the growth of the plants being under perfect and immediate control according to the requirements of the crop and the nature of the soil. In other words, this process is the first attempt made to strengthen the manurial properties of the otherwise miserably weak sewage water, and, at the same time, to so far effect its purification that it can be employed without offence—a feature which distinguishes this system of treating sewage from all other attempts to deodorise or disinfect it which depend upon the addition of substances which, if they do not lower the value of the sewage for agricultural purposes, do certainly not augment it.

II. Sewage Precipitation.

Although, as before stated, sewage irrigation, in all cases where the local circumstances are favourable for its employment, must be regarded as the most likely method of purifying the sewage, and, at the same time, obtaining the greatest agricultural value out of a given quantity of sewage water, there are, nevertheless, many instances in which the application of this system is altogether impracticable or not attended with corresponding advantages. In the first place, the outlay for machinery and appliances for collecting, pumping, and distributing the sewage in towns, may often be so enormous as to deter the ratepayers whose shoulders have to bear the burden, from adopting so expensive a system, especially when they remember that the area of land required to be secured for utilising by irrigation the entire sewage of even a moderately sized town is extremly large as well as most costly to purchase, owing to the price of land in the vicinity of towns in these days of cheap railway communication being, as is well known, out of all proportion to its mere agricultural value.

In many places, also, the soil is a stiff, non-absorbent clay, which, instead of allowing the sewage to sink into it allows it merely to flow off its surface into the watercourses without undergoing any purification; in other places. well-drained, porous, and absorbent land, such as is alone suitable for sewage irrigation, is not to be had at all, or only at such great distances as still further to augment the outlay required in the first instance.

When considering this subject it must never be forgot that the purification effected by sewage irrigation is mainly dependent on the chemical forces brought into activity by the growth of vegetation, and which, consequently, is more and more powerful in proportion as the vegetation itself is more luxuriant and the reverse; so that in winter, when in our climate vegetation continues in a torpid and almost dormant state, it naturally follows that the power of assimilating, which, in other words, means purifying and extracting the agricultural value out of the sewage water, is reduced to its minimum at a time when, owing to the extra rainfall at this season of the year, we are, nevertheless, obliged to continue drenching the land already, perhaps, supersaturated with moisture, with even far more sewage water than is supplied to it at other times of the year when the plant most requires it, and thus, by keeping its roots continually wet and cold, we are supposed to injure its health,—an opinion which most farmers who know the beneficial effects of good draining will probably endorse. At the same time it would be but deceiving ourselves to suppose that land thus irrigated in winter could retain or store up until spring other than a very small portion of the more valuable fertilising ingredients in the sewage water, such as the ammoniacal salts, nitrates, &c., for these substances being of an extremely soluble nature, must be in greater part washed out and carried off with the natural drainage-water of the land in the event of the plants themselves not being in a condition to arrest and assimilate them.

No one, therefore, who takes all these circumstances into due consideration can fail to be convinced of the great desirability and importance of having at command some system by which at certain seasons of the year or in localities unsuited for irrigation, the sewage may be at once purified by precipitation to such an extent that the effluent water may be run directly into the sea or nearest river: with this object, therefore, a modification of the phosphate process, already described, has been devised, which, after numerous trials on a working scale at the Tottenham sewage works and elsewhere, has given the most satisfactory results.

The process itself may be described in a few words, since it is of the simplest nature and requires no machinery or special appliances beyond the tanks or reservoirs. A suitable quantity of the solution of the native phosphate of alumina in sulphuric or hydrochloric acid is allowed to run along with, and so mix itself with, the sewage as it enters the tanks, precisely as when it is used in clarifying the sewage employed for irrigation as before described. Instead, however, of allowing the clarification to proceed and the suspended matter in the sewage to settle down, a quantity of milk of lime, just sufficient to neutralise the acid in the phosphate solution, is immediately afterwards also run into the tank for the purpose of precipitating the soluble phosphates thus added to the sewage, and by so doing effect a still further purification of the water.

The precipitated matters subside rapidly, and the supernatant water is at once seen to become colourless, clear, and soon loses any offensive odour or taste. The time required for the complete purification varies considerably with the quality and nature of the sewage, rarely requiring more than from three to eight hours, after which the supernatant water may be drawn off from the deposit (preferably by an arrangement which commences drawing or pumping it off first, from the surface downwards) and can be discharged directly into the neighbouring stream without destroying the fish or otherwise polluting them to any sensible extent.

Effluent Water.—With regard to the effluent water from this process, it is not pretended that it attains any such high degree of purity as to admit of comparison otherwise than in appearance with the water supplied for the water works, and it should be recollected that the object of the process is to purify sewage, not to manufacture drinking water out of it. It has, however, been already demonstrated by experiment, that sewage from London, Liverpool, Swindon, Birmingham, Coventry, Tottenham, and several other towns, when so treated, yields effluent water quite as clear and colourless as ordinary river water; whilst it is so free from any disagreeable smell or taste that it may be taken into the mouth and drunk without

repugnance; nor does it upon standing deposit any offensive sediment. Fish, as may be seen at Tottenham, even when in confinement, live and thrive in the purified sewage water. The effluent water from London sewage taken at the Barking Creek outlet, when thus purified, remained during the entire hot summer of last year without evincing either in open or closed vessels any tendency to putrefy or emit any offensive odour.

In face of the above facts, it is maintained that such water may be allowed to flow directly into any river without occasioning any offensive deposits in its bed, polluting the water to any sensible degree, or causing injury either to the fish in them or the health of the inhabitants on the banks.

Sewage Precipitate or Manure.—The sediment or deposit thrown down from the sewage in this process of precipitation, contains the entire amount of mechanically suspended matter present in the sewage, along with much of the organic matter (particularly the nitrogenous or albumenoid) held in solution in the sewage previous to its purification, and the whole of the phosphates employed in the process, which now, however, are in a much more valuable condition, since they are precipitated in a hydrated or soluble state fit for being at once taken up by the plants.

It is not pretended, however, that this process extracts anything like the entire fertilising ingredients contained in the sewage, since it is admitted that by far the largest portion of the ammonia present in the sewage flows off with the effluent water, and is consequently lost unless this water is employed for the purpose of irrigation.

The precipitate is in itself, however, a valuable manure, which is mainly owing to the most important and characteristic feature of the phosphate process, in which it differs from all processes now in use, which is that the substances employed in effecting the purification of the sewage are only such as augment greatly the agricultural value of the precipitated deposit, which can be increased at pleasure by merely adding more of the phosphate, so that it can by this means be rendered sufficiently valuable to bear the cost of transport to a distance from the seat of manufacture.

The proportion of the native phosphate of alumina required in this process naturally varies according to the strength and character of the sewage. Although in some cases less than half this quantity was found to be sufficient, the actual amount now employed on the large scale at the Tottenham sewage works is in the proportion of 1 ton of the crude phosphate to 500,000 gallons of sewage.

The crude phosphate is prepared merely by mixing it in the state of powder, with sulphuric acid in the proportion of 1 ton of the phosphate to from 12 to 14 cwts. acid (170° Twaddle), and allowing it to stand a short time; the prepared phosphate has then the appearance of a brown paste of about the consistence of stiff clay, and only required being dissolved in water, and allowed to flow into the sewage in the proper proportions. The lime employed was ordinary burnt limestone or chalk slaked in water, and before being added to the sewage was stirred up in a tank with as much water as would bring it into the condition of so-called milk of lime. The amount employed varied with the quality of the sewage, and the quantity of phosphate added; it was, however, always added until the sewage acquired a very faint alkaline reaction, which, in the case of the Tottenham sewage, required in general the addition of about one-half the weight of the prepared phosphate previously employed.

The native phosphate of alumina contains from 30 to 40 per cent of phosphoric acid (equivalent to from 65 to 87 per cent tribasic phosphate of lime), and consequently at its present price of £3 10s. per ton is probably the cheapest of all sources of phosphoric acid known in the market. When, however, it has been dissolved in acids and re-precipitated by lime, it is then converted into hydrated phosphates, which, weight for weight, are then worth fully double the value of the original crude phosphate, since they are then much more soluble and readily available for plants. Against this increased value must, however, be placed the expense of the acid, labour, &c., so that except in manufacturing districts, this is not expected to leave any great margin of profit; still there can be little doubt but that it will as a rule be found more profitable to use considerably more phosphate (say 2 tons to the million gallons of sewage) than is absolutely necessary to effect its purification, in order to augment the market value of manure, and so to a great extent make the process a self-paying one.

In practice, the quality of the manure must naturally be regulated to suit the market of each locality, and it will probably be found most advantageous to add as much phosphate to the sewage as will enable the manure to find a ready sale at a price somewhere between £3 and £5 per ton; in order, however, to have an unbiassed and competent opinion on the value of a high class manure of this character, Dr. Voelcker was requested to treat a quantity of London sewage by this process, and report his analysis of the deposited manure.

The whole experiment was left entirely in the hands of Dr. Voelcker, who procured the sewage from London Bridge, and reported as follows:—

My Dear Sir,—The following is the composition of the sewage deposit which you desired me to analyse:—

100 parts of the dry sewage deposit contain:—

Moisture (loss on drying at 212° F.)	3·98
*Organic matter and water of combination	20·11
†Phosphoric acid	28·52
Lime	13·09
Alumina and oxide of iron, and a little magnesia and alkaline salts	29·95
Insoluble siliceous matter	4·35
	100·00

* Containing nitrogen 0·57; equal to ammonia, 0·69.

† Equal to tribasic phosphate of lime, 62·26.

The whole of the phosphoric acid, I may state, occurs in this manure in the shape of precipitated phosphates, a form I need hardly say in which the phosphates are readily available by plants. The presence of a large amount of water of combination in the deposit, that is, water which is not expelled on drying at the boiling-point of water, shows that the phosphate with which the water enters into chemical combination, and which does not escape at 212° F., are not likely to return readily into the ordinary and, comparatively speaking, ineffective condition in which they exist in phosphatic minerals. Being obtained by precipitation from their solution, the phosphates are present in the deposit in a very efficacious form.

The sample analysed by me contains an amount of such precipitated phosphate, which is equivalent to 62 per cent of tribasic phosphate of lime, and an appreciable amount of nitrogenous organic matter, capable of yielding 0·69 per cent of ammonia.

It possesses valuable fertilising properties, and in my opinion, a sewage manure, equal to the sample analysed by me will command a ready sale at £7 7s. per ton.—Believe me, yours faithfully,

(Signed) AUGUSTUS VOELCKER.

A. P. Price, Esq.

When perusing the above report, however, it must be borne in mind that this high estimated price is not due to the matter actually precipitated out of the sewage itself, the agricultural value of such sewage precipitate (independent of the phosphates added in the process) being probably seldom more than £2 10s. per ton, if so high; on the contrary, it is all but entirely due to the value of the phosphates added in the process, which must be paid for, together with the cost of acid * and labour required in

* In such manufacturing towns as produce muriatic acid as a waste product which can be bought at a nominal price, this acid could be used instead of sulphuric acid, and would, no doubt, bear a handsome profit.

the manufacture to bring them into the soluble condition; consequently, as before mentioned, the profit, if any, will be but small, and not sufficient to encourage the belief that the ratepayers can altogether escape putting their hands into their pockets in order to cover the expense of disposing of their sewage.

There is every reason, however, for believing that the manure produced in this process, if it does not actually cover the expense, will at least go a long way towards doing so; and when the small outlay required to start this process is compared with the enormous capital necessary in most cases to carry out the elaborate plans of sewage irrigation, it is believed that in many instances this system of sewage precipitation will be found considerably more advantageous and economical in practice.

ON THE ANALYSIS OF CHLORAL-HYDRATE.

By K. MULLER.

THE method of dissolving chloral-hydrate in ammonia, as also in caustic alkalies, with the application of heat, has shown unsatisfactory results, differing very materially from each other; the cause of these deviations was in the partial transformation (taking place at 50° C.) of the chloroform, under the influence of caustic potash, into chloride of potassium and formiate of potash, according to the formula—

$$\underbrace{CHCl_3}_{\text{Chloroform.}} + 4KOH = \underbrace{CHOKO}_{\text{Formiate of potash.}} + 3KCl + 2H_2O.$$

All heating, therefore, has to be avoided; and for this purpose the decomposition is carried out in a burette, divided from the bottom into tenths of cubic centimetres, in such a manner that 25 grms. of chloral-hydrate are carefully covered by a layer of a dilute solution of caustic potash in water. This is allowed to remain for about fifteen minutes, and the decomposition is completed by careful and thorough shaking. After the lapse of several hours, the reaction is completed, and both liquids —viz., chloroform and a solution of formiate of potash, with some caustic potash, have separated clearly and distinctly. It is now only necessary to read off the cubic centimetres of the lower layer of chloroform, and then multiply it with the specific gravity of the chloroform (1·525 at 32° F.), in order to arrive at the weight produced (in grammes), and thereby calculate the percentage.

I first directed my attention to the chloral-hydrate manufactured by Mr. E. Saame, of Louisenhall, near Gottingen, as being the most convenient for me, and whose process of manufacture (agreeing fully with that recommended by Dr. O. Liebreich) I had often the opportunity of observing.

The results I obtained are as follows:—

Sample No.	Manufacturer, and by whom supplied.		Boiling-pt. Cent.	Weight of Chloroform obtained from 25 grms	Percentage of Chloroform.	General Remarks.
				Grms.	Per ct.	
1.	Manufactured by Mr. E. Saame, and supplied by Messrs. H. and G. Schoettensack London.	Cake.	96·5	17·98	71·9	A crystalline cake of dazzling whiteness; agreeable, slightly pungent chloral odour; easily soluble in water; melting-point, 52° Cent.
2.		Powder.	96·5	17·98	71·9	A white powder; results same as above.
3.		Crystals.	97·3	17·85	71·4	Colourless, transparent, well-formed, large rhomboid crystals, with an agreeable odour; soluble in water.

I therefore recommend my simple method, as shown above, to every chemist, in order that he may be able to form, with little trouble, a judgment of the value of chloral-hydrate supplied to him.

Laboratory, University of Göttingen,
January, 1871.

ON THE ANALYSIS OF AN ALKALINE SPRING FROM CATHKIN, NEAR RUTHERGLEN.

By J. WALLACE YOUNG.

THIS spring issues from a bore, put down by the proprietor of the ground, in order to ascertain if any workable minerals were to be found. It is in the carboniferous formation bordering on the Trappean Hills of the district. Unfortunately, I cannot give any information as to the depth or the nature of the strata passed through.

Water clear and colourless, does not deposit anything on standing. Turmeric paper immersed in the water for a short time gives a well-marked alkaline reaction.

	Grs. per gallon.	Grs. per 100,000.
Total residue	35·700	51·000
Consisting of—		
Volatile and combustible matter	0·650	0·925
Fixed residue	35·050	50·075
The fixed residue consisted of—		
Lime	0·890	1·271
Magnesia	0·320	0·457
Soda	17·410	24·871
Sodium	1·270	1·814
Silicic anhydride	0·400	0·571
Carbonic anhydride	13·420	19·171
Sulphuric anhydride	trace	trace
Chlorine	1·950	2·785
Peroxides of iron and alumina	trace	trace
	35·660	50·940

The soda was determined both directly and indirectly, the two results closely agreeing. A sufficient quantity of soda to saturate the chlorine has been calculated as sodium.

The total quantity of carbonic anhydride present in the water was determined in two different samples, taken at different times, the result being similar.

	Grs. per gallon.	Grs. per 100,000.
Total CO_2 by experiment	26·95	38·500
Total CO_2 required to convert the bases into bicarbonates	26·84	38·342
Excess of CO_2	0·11	0·158

I have arranged the constituents as follows, but, as I have given the original figures, any one can make an arrangement to suit himself.

The silicic anhydride is probably combined with part of the soda, but I have followed the usual custom of putting it down alone.

	Grs. per gallon.	Grs. per 100,000.
Bicarbonate of lime	2·30	3·285
Bicarbonate of magnesia	1·03	1·471
Bicarbonate of soda	42·11	60·157
Chloride of sodium	3·22	4·600
Silica	0·40	0·571
	49·06	70·084

No nitrates present. The residue of the water, when examined with the spectroscope, showed nothing but the sodium line.

The absence of sulphuric acid is rather remarkable. Most of the deep well waters of London contain more or less carbonate of soda, but the composition otherwise is

very different (see Dr. Odling's paper "An Account of Guy's Hospital Well," in the CHEMICAL NEWS, vol. iii., pp. 35 and 49).

In the *Philosophical Magazine* for May, 1860, there is also an analysis, given by Mr. Abel, of a water from the coal strata of Bradford Moor, Yorkshire, which contains 43·53 grs. per gallon of bicarbonate of soda.

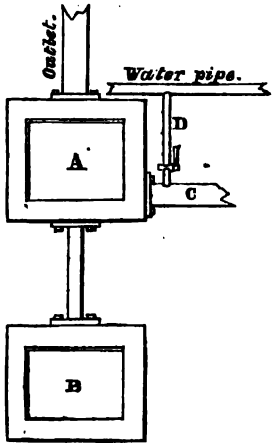
NOTE ON THE PUMPING OF HOT LIQUIDS.

By J. SUTHERLAND.

HAVING occasion last summer to erect pumping apparatus to pump off hot lyes from two large soap pans, I experienced considerable difficulty in getting a sufficient flow of the liquid when its temperature was at all near the boiling point,

When the pump was set on, and the connections cold, it threw well for two or three minutes, but directly the metal became heated to the temperature of the liquid, we could pump almost nothing but vapour.

This result, of course, arose from the well-known fact that liquids boil at lower temperatures exactly as the pressure on its surface is decreased. The pump itself was



simply a steam cylinder, having a set of ports opened and closed by slide valves, and producing an exhaust by means both of the up and the down stroke. This arrangement gave excellent results so long as the liquid was comparatively cold, throwing a continuous stream 2½-inch bore or about 10 to 12 tons spent-lye per hour. Our spent lyes are usually very hot, however, and, as we could not possibly wait till they cooled, the pump must do duty at any temperature. Of course, the cause of failure was due to the exhaust produced by the pump being as rapidly filled up as formed by the vapours generated from the liquid, brought to a state of ebullition by the decreased pressure produced in the pump connection.

Had it been admissible to place a foot-valve, opening inward, at the lower end of the inlet pipe, it would, probably, have done some good, but, in our case, this was not allowable.

It then occurred to me that if I could introduce a fine spray of cold water at the inlet of the pump it would condense the troublesome vapour and allow the pump to do its work. A water-pipe passed along the wall within a foot or two of the inlet, and, between the two, I opened a connection with a ¼-inch lead pipe having a stop-cock to regulate or shut off the water supply. The end fitting into the cast-metal pipe was filled with a small rose in order to spread the water on entering. The accompanying rough sketch shows the arrangement.

A is the pump cylinder, B the steam cylinder, C a 3-inch inlet, D ¼-inch pipe introduced on the upper surface of the inlet pipe. It is imperative that it be introduced on the upper surface of a horizontal pipe as it is there the first vapour will gather and be exposed to the condensing action of the spray. Were the cold water introduced at the lower surface of the pipe it would mix with the hot liquid and, in all probability, its action would be almost *nil*. The application proved a thorough cure, and not more than about ¼th of an inch bore of water was necessary to set the 3-inch inlet in full action.

ON FERMENTATION.*

By Professor A. W. WILLIAMSON, F.R.S.

(Concluded from p. 103).

M. PASTEUR has introduced a process which, I gather from his statements, has already been adopted by a considerable number of wine-growers and merchants, which goes to the root of the matter in such a way as to leave nothing to chance, for he has proceeded upon the knowledge previously acquired by his accurate and masterly experiments, regarding the nature of all these little organisms, and the conditions which are favourable to their development, and which are destructive of them. He finds that when wine is heated to near the boiling-point in any vessel in which it may be enclosed, and left in that vessel to cool, it may then be kept (provided the vessel be not opened) for any length of time without undergoing any of these deleterious changes. He finds also that so high a temperature as that I have named is not absolutely necessary, but that even if wine, which on keeping would be subject to the malady of acetification or ropiness, be heated to a temperature of 60° C. (that is, about 140° in the clumsy and inconvenient scale which is still, I am sorry to say, in common use in this country), it will kill these organisms completely; and the experiment is so easily performed that any of you may do it with a very moderate amount of care. You ought to perform the experiment with several bottles at the same time, and to keep some similar bottles in the original state, in order to observe the difference. In the month of September, when I last saw M. Pasteur, he gave me several bottles of wine, some of which were in their original state, whilst the others had, after bottling, been heated to a temperature of 60°, or a little more. I have not yet opened any of them, but I have some of each sort here, and we will presently see what has been the result of the treatment. I ought to say that they have not been kept with proper precautions, for, on opening the case, I found that it had been left in such a position that the bottles had been standing with their necks upwards, which is not very favourable to the preservation of the wine. The experiment is so simple, that it is worth while for everybody to perform it. You should take some light wine, which you have reason to believe will not keep well; the bottles should not be too tightly corked, and there should be a little space left below the cork. You put several of these bottles into a vessel of water, cautiously if the water be warm, to avoid breaking them, and with them one bottle full of water, uncorked; you then warm the whole very gradually, until you find, by inserting a thermometer into the open bottle of water, that the temperature is up to 140° F.; you then allow the whole to cool slowly. The corks are generally lifted a little by the expansion of the liquid and air within the bottles, and will require to be struck in again to their proper place. The same operation is performed on a large scale by wine-growers and merchants in France, in casks, and several contrivances have been described for the purpose. The simplest of all is to put a cask, with

* The Cantor Lectures. Delivered before the Society of Arts.

its bung upwards, into any convenient vessel of water, so placing it that the top of the cask is just above the water. The water surrounding the cask is then warmed gradually until it is found, by lifting the bung and inserting a thermometer, that the wine is of a temperature 60° or 70° C. The bung is then closed, and the whole allowed to cool. Another form of apparatus has been figured in a late book of M. Pasteur's on acetification, which consists of a cask with one of its ends removed, and replaced by a sort of double bottom of metal. This cask is then put on the fire, so that the water in the false bottom may be heated, and raise the temperature of the wine in the cask above, without danger of burning it. M. Pasteur recommends that when the wine has reached the right temperature it should be allowed to run, while still hot, into the cask into which it is to be kept, so that any little germs which may be present there may be as much heated as the wine which comes in contact with them. He heats the wine in this operation to about 65° or 70°, but he says there is reason to believe that even 50° is sufficient. Upon all occasions on which it has been tested it has been found that the little parasites which are present, and which are the seeds of the maladies of which we have been speaking—and, no doubt, other organisms, are changed in such a manner as to be practically dead. Whether they are susceptible of being revived is another thing. It is not known and it is not affirmed that there are no germs which might not, by contact with oxygen, be afterwards brought into life; but practically there are no organisms in the wine, after that temperature has been applied to it, capable of growing in the closed vessel in which it is kept. M. Pasteur says that if the wine were, after that treatment, bottled, he would expect that some bottles would contain wine which would spoil, whereas the greater number probably would not, the reason being that the wine, on its passage from the cask to the bottle, would be liable to get some little germs from the air which possibly might retain some vitality, which would be stimulated by the oxygen. Therefore, all he affirms is, that when the wine is kept in the same vessel in which it was heated, it undergoes no further change whatever.

With regard to the ordinary process of aërating wine by keeping it in bottles, I should like to show you an experiment which illustrates, in a very simple way, what is a very familiar well-known fact. Every one who has had occasion to keep wine knows what an immense difference there is if you keep a bottle standing upwards or lying down. The difference is of this kind. If it stands upwards, the cork is dry, and air has access at a very rapid rate to the contents of the bottle, and the wine gets oxidised and spoilt; whereas, when the bottle is left lying down, the cork is wet, and the air has access much less rapidly,—in fact, only at such a low rate as is suitable for mellowing and improving the wine. I have here a couple of glass tubes, both open at one end, and closed at the upper end by a porous substance, which I may call a cork—it is, in fact, a cork made of plaster of Paris, a particularly porous substance,—one cork being wetted, so that the pores are full of water, whilst the other has been carefully kept dry, and this one is covered for the present with a little cap to prevent the access of the air. Here, in another vessel, is a mixture which is giving off hydrogen gas, which is passing upwards into these two tubes, one with a wet cork and one with a dry one. After a minute or two, both tubes will be full of pretty nearly pure hydrogen, and then we will remove them, and put the lower ends into this jar containing a coloured liquid. Most of you know that this porous substance allows hydrogen to pass through it more rapidly even than the air which is now outside passes in, and therefore as the hydrogen passes out of these tubes more rapidly than the air comes in, the liquid will be sucked up in the tubes, and we shall have a measure of the rate at which our gas passes through the wet cork and the dry cork, by noticing the difference in the rise of the liquid in the two tubes. If it passes quicker through the dry cork than the wet one, we shall find that the liquid will rise more rapidly in that tube, and I think you will find that the difference will be very great indeed. They are now both standing in the coloured liquid, and already there is a perceptible rise in the tube with the dry plug; but in the other one I cannot yet see the liquid at all. So it is in the simple case of a wine bottle. If the cork of a bottle is wetted, so as to allow an exceedingly slow diffusion of air through the contents, the wine gets very slowly oxidised, and undergoes only that gradual transformation which is wanted; whereas, in the other case, it is turned sour and spoilt by too rapid oxidation.

I could gladly have entered upon many other facts and considerations which belongs to this subject, but one must stop somewhere. I cannot, however, part from you without expressing my very strong sense of the debt which we owe to that great investigator whom I have already quoted so many times, I think there are few precedents of research so fruitful as those of M. Pasteur, if we consider, not only the theoretical importance, I mean with regard to our knowledge of the processes of life, and the origin of life, of his investigations regarding germs in the air, and these processes of fermentation; but if we take into account also the fact that he has succeeded in working out one of the most complete practical applications of it in a process like wine-making and keeping,—we cannot refrain from admiring the truly perfect adaptation of the highest science to a useful purpose. I will now proceed to open these two sets of bottles, some of which have been heated and some not, and I hope the rusult will be satisfactory.

[The samples of wine were then tasted by the audience, the difference being most remarkable, not only in taste, but also in colour and general appearance.]

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

March 2nd, 1871.

Professor Williamson, F.R.S., President, in the Chair.

The following gentlemen were elected Fellows:—G. D. Harding, W. H. Hudleston, A. H. Mason, J. J. Nicholson.

The following papers were read:—

"*On the Distillation and Boiling-Point of Glycerin*," by Thomas Bolas. It is well known that, when glycerin, subjected to the ordinary atmospheric pressure, is heated so much as to cause ebullition, it is more or less rapidly decomposed by repeated distillations. This decomposition may be, however, entirely prevented by a reduction of the pressure in the apparatus employed to 12·50 m.m. The boiling-point of glycerin was determined by effecting the distillation in a long-necked flask, having a supplementary neck attached at right angles to the principal one. In the principal neck, the thermometer was fixed by the aid of a caoutchouc cork, while the smaller neck was connected in a similar manner with a two-necked receiver. The glycerine, together with a few fragments of tobacco-pipe (this latter being required to prevent the bumping which would otherwise occur), being placed in the retort-flask, the receiver was connected with a Sprengel's mercurial pump and a manometer, the caoutchouc joints being made air-tight with glycerin in the usual way. Unless the glycerine distilled had been dehydrated by previous distillation in a vacuum, the first portion of the distillate consisted principally of water; afterwards, when the glycerine in a pure state came over, the temperature indicated

by the thermometer was 179·5° C. At this time, the pressure on the liquid was 12·5 m.m., a pressure nearly corresponding to the tension of aqueous vapour at the temperature of the receiver. A determination of the carbon and hydrogen in the glycerin distilled as above was made; the oxidant employed being copper oxide, followed by oxygen gas, (I.), 0·4281 grm. CO_2 and 0·3439 grm. H_2O.

	Theory.		Found.
			I.
C_3	36	39·1	38·9
H_8	8	8·7	8·9
O_3	48	52·2	
	92	100·0	

Under a pressure of 50 m.m., glycerin distils without change at about 210° C. Glycerin, dehydrated by distillation, absorbs water from the atmosphere to the extent of about 50 per cent of its weight. The amount absorbed is, as might be expected, very variable.

"*On the Action of Heat on Silver Nitrite*," by Edward Divers, M.D. The products of this action consist principally of silver nitrate, reguline silver, and oxides of nitrogen. But the relative proportions of the quantities of these substances to each other, and, as a consequence of this, the composition also of the gaseous matter, vary considerably in different experiments. When silver nitrite is heated in a crucible or watch-glass over a lamp, its decomposition becomes first evident by its turning grey when in contact with the hot crucible, and by its giving off red fumes. The mass very soon enters into a state of semi-fusion, and then becomes solid again, and of a whitish grey in some parts and greenish yellow in others, red fumes still being produced (but much less copiously than during the intumescence). Lastly, on continuing the heat, the yellow portions of the mass slowly change to grey, like the rest, with the formation of a small quantity more of red fumes. Prolongation of the heat beyond this point causes the glass or porcelain to be attacked; but, as the entire greying of the mass has been found to be a sign that nothing, or almost nothing, remained but silver nitrate and free silver, it is here unnecessary to pursue, beyond this point, the changes which take place. As there is found to be a material difference in the loss of weight sustained in different experiments, it might naturally be supposed at first that this is due to a decomposition of the silver nitrate formed. But that it is not so is shown, firstly, by the fact that longer heating at about the same temperature causes very little more loss; secondly, that the temperature does not appear to be so high as that required for the free decomposition of silver nitrate; and thirdly, that the loss sustained bears no direct relation to the degree of heat employed. When the nitrate in an open dish is heated in an oven at any temperature between about 85° on the one side, and 140° C. on the other, it loses its sensible characters almost imperceptibly, becoming whitish grey and non-crystalline, without fusion or any apparent change in bulk. The change which takes place in the nitrite when it is heated in an open vessel in either of the above ways, does not generally differ very much in its results from that represented by the equation—

$$3NO_2Ag = N_2O_3 + Ag_2 + NO_3Ag.$$

When, instead of employing an open crucible, or dish, for heating the nitrite over the lamp, a closely-covered one is used, so that the gaseous and fixed products of decomposition may be kept for a time in contact, the loss of weight experienced by the mass is less, and the amount of nitrate formed greater. The ultimate change effected in this way approaches, though not closely, to that expressed by the equation—

$$2NO_2Ag = NO + Ag + NO_3Ag.$$

The effect of keeping gases given off in contact with the undecomposed nitrite remaining is to cause nitric oxide alone to be lost. This has been shown by heating the nitrite in a vessel nearly closed, so as to decompose the nitrite very gradually. 0·4433 grm. of the nitrite were placed in a small tube, and the empty portion of the tube filled up by a glass rod barely small enough to be pushed into it. After twelve hours at about 90°, it weighed 0·4431 grm.; after twelve more at 95°—99°, it weighed 0·4437; after twelve hours more at 115°—135°, 0·446 grm.; after fourteen hours more at about 134°, it weighed 0·450 grm.; after again fourteen hours, mostly at 136°, 0·453 grm.; and after fourteen hours more, when the heating was discontinued, 0·4544 grm. There was, therefore, instead of a loss, a material gain in weight equal to 0·0111 grm. Faintly reddish gas was first detected in the tube at 115°. At 134°, the crystals began to shrink and fuse together, and this occurred first near the stopper of the tube, and only very slowly proceeded backwards to the end of the tube. It would not, therefore, be right to conclude that silver nitrite fuses at this temperature; the fusion apparently taking place only in the nitrite after it had become mixed with nitrate. During the heating the mass scarcely altered in colour. The explanation of the gain in weight is, of course, evident. The nitrite decomposing and evolving nitric peroxide, or at any rate a nitrogen oxide, this becomes reduced to nitric oxide, if not already such, by oxidising unchanged nitrite; the nitric oxide then serves as a carrier of atmospheric oxygen to the nitrite, as it is known to do to other substances. The extent to which atmospheric oxygen was thus fixed in the preceding experiment is more fully shown by the examination which was made of the contents of the tube. These were treated with water, and found to contain 0·0216 grm. of metallic silver, which, therefore, as nitrite had been in combination with 0·0092 grm. of gaseous matter. This loss being balanced against the oxygen absorbed, its weight must evidently be added to the observed gain in weight to obtain the actual amount of oxygen absorbed by the rest of the nitrite. The total oxygen absorbed is, therefore, equal to 0·0203 grm.; of this, about 0·017 grm. must have been derived from the air, the rest coming from the decomposed nitrite, thus: $NO_2Ag = Ag + NO + O$.

It is calculated that not very much less than half the nitrite was converted into nitrate in this experiment. This experiment is sufficient to establish that hot nitrate reduces the higher oxides of nitrogen to nitric oxide; so that we have proof that the tendency under one set of circumstances is to ultimately convert nitrite into the products metallic silver, nitric oxide, and silver nitrate, according to the equation already given. But it is quite clear that nitric oxide and the silver nitrate are secondary products of the action of heat. This can, however, be shown in another way to be undoubtedly the case, as in the following experiments:—2·098 grms. were heated in a dish in an oven for seventy-two hours, at a temperature of about 98°, in a moist atmosphere obtained by keeping a dish of water in the oven. The loss in this experiment is equal to 0·441 grm., and the residual mass, after washing out with water and re-ignition, yielded 1·157 grms. of silver. The soluble matter contained a little nitrite. 0·794 grm. was heated for about ninety-five hours in an atmosphere of steam at a temperature rising from 98° to 140°. The residue weighed 0·580 grm. This experiment was not pursued further. These two experiments are sufficient to establish the fact that, under a given set of conditions—viz., free exposure in a moist atmosphere—silver nitrite tends to yield only metallic silver and nitrogen peroxide, thus: $NO_2Ag = Ag + NO_2$. The conclusion, then, from all these experiments is that, like other silver salts, the nitrite splits up, under the influence of heat, into metallic silver, and the acid radical, or its components, and that silver nitrate, nitric oxide, and perhaps nitrous anhydride, are formed only by secondary reactions. With regard to nitrous anhydride, the experiments which have been here given to prove that the gases evolved are either nitrous anhydride or its equivalent furnish no proof that they actually include this body. The fusion which occurs in

the mass of heated nitrite, so soon as it has undergone some oxidation, suggests that the nitrate formed combines with the nitrite to form a nitrite-nitrate or hyponitrate; the point at which this fusion occurs is far below that at which silver nitrate fuses. In one experiment, the nitrate formed is calculated to have been in nearly the proportion of one atom to one atom of the undecomposed nitrite; it is, therefore, not improbable that an unstable nitrite-nitrate exists.

The silver nitrite Dr. Divers had employed in his experiments had been carefully prepared, and some of it ascertained to contain 70·06 per cent silver. The theoretical quantity is 70·13.

The President inquired in what way Dr. Divers had ascertained that the solid residue contained no argentic oxide.

Dr. Divers replied that the residue had the appearance of metallic silver, and that, after weighing it, he had subjected it to strong ignition, and then weighed it again, when usually no difference presented itself in the two weighings. In one case only, there was, after ignition, a loss of less than ½ a milligramme.

Dr. Odling asked what were the evidences for the existence of a silver nitrite-nitrate. The fact of such a compound existing would greatly modify the views at present entertained on the constitution of salts.

Dr. Divers said that he deduces it from the circumstances that the nitrite began to fuse at about 140°, after partial decomposition. Since the fusing-point of silver nitrate is much above that degree, he is inclined to attribute it to a compound of the nitrite and the nitrate, which, like alloys, may have an intermediate fusing-point; but, on the whole, he considers the combination only a loose one.

Dr. Odling observed that the circumstance Dr. Divers had mentioned proved merely that there was a mixture of the two salts, since it is well known that such mixtures fuse at some lower degree of temperature than either of the salts separately.

Dr. Divers agreed with Dr. Odling that the evidence for a nitrite-nitrate is but a slender one. He wished, however, to point to one of the experiments mentioned in his paper where the proportion of the nitrate formed to that of the nitrite left undecomposed was that of one atom to one atom. He, moreover, had reasons to doubt the existence of a silver hyponitrate, silver being monovalent. It stood differently with lead, which is a divalent element.

Dr. Armstrong, with regard to the latter opinion, remarked that Professor Wislicenus, of Zürich, had, in a recent publication,* stated some reasons for viewing silver as a divalent metal.

Dr. Mills asked what proof there was that the gas really was nitrous acid, and not a mixture of nitric oxide and oxygen.

Dr. Divers did not insist rigidly upon that view: it may be, perhaps, such a mixture.

After the reading of the above papers, Dr. Gladstone communicated some remarks "*On the Relations of Chemical Reaction and Time.*" He had instituted most varied experiments bearing on this subject, and in briefly alluding to some of them he wished to call the attention of chemists to this wide field of inquiry. Hitherto, observation seems to be limited only to the circumstances at, and the products with, which a chemical reaction begins and ends; all that happens between was left wholly unnoticed. Yet, how fruitful attention paid to the intermediate stages and products of a reaction could be was seen in the beautiful results which Professor Williamson had gained in his researches on etherification.

The President, Dr. Odling, Mr. Vernon Harcourt, and others concurred in Dr. Gladstone's view as to the importance of a closer study of this subject.

* *Berichte der Deutschen Chemischen Gesellschaft zu Berlin*, iv. Jahrg., p. 63.

CORRESPONDENCE.

JOULE AND SCORESBY'S EXPERIMENTS.

To the Editor of the Chemical News.

Sir,—Let me thank Mr. Apjohn for his letter to you published in the Chemical News of March 3rd.

As my only object is truth, I shall gladly yield any point in which I am convinced of error.

(1). In the first place, therefore, let me say that if I appeared to express a doubt that a grain of zinc could be doing a maximum *duty* when doing least *work* in a given time, I retract my expression.

(2). Next let me say that after reading Mr. Apjohn's explanations of Joule and Scoresby's arguments, I am as little satisfied with their reasonings as before, though I confess, I somewhat misunderstood them. If, indeed, it be true (and on reading Mr. Apjohn's explanation I think it is true) "that the assumption $H : H' :: a^2 : b^2$ (H, H' representing the heat, and a and b the intensities of the currents) is not an irrelevant statement, but is, in fact, the fundamental principle on which the formula is based," then I reply that the formula is based on a false principle. For the heat is as the square of the intensity only when the resistances are equal. And in this case the resistances are not equal, the working of the engine introducing a fresh element of resistance.

(3). Mr. Apjohn says that "if I had said and understood that the heat evolved per "*given quantity*" of zinc consumed was directly proportional to the intensities, I should have been quite correct, and should probably have avoided the subsequent errors into which I have fallen." On the contrary, I maintain that the heat evolved in a given battery by a "*given quantity*" of zinc is *always* the same and does not vary as the intensity or in any other manner.

(4). Mr. Apjohn says "Mr. Highton should have known that $(a-b)$ represents the difference of heat evolved per grain of zinc, and not, as he supposed, the difference between the total amounts of heat produced by the battery in each case, which would be represented by a^2-b^2." On the contrary, I assert that, *with the same battery*, if the resistance be varied so as to reduce the intensity from a to b, the *total amount* of heat produced by the battery in a given time is reduced in the proportion of a to b, and not in the proportion of a^2 to b^2.

(5). If Joule and Scoresby assert, as they do, that $a-b$ represents the diminution of intensity, and the diminution of consumption of zinc, and also the amount of heat converted into useful mechanical effect, I think I was justified in drawing the conclusion that this involved the assumption that a less quantity of zinc produced an equal amount of heat, but that part of this heat was absorbed in doing work. I confess I do not see how this inference can be avoided. I conclude, then, that though Mr. Apjohn has certainly shown that I misapprehended part of Joule and Scoresby's reasoning, this does not affect the general result or make their position more tenable.—I am, &c.,

H. Highton.

Putney, March 4, 1871.

NITROGEN TRIOXIDE A SUPPORTER OF COMBUSTION.

To the Editor of the Chemical News.

Sir,—Some weeks ago one of your correspondents rediscovered that tin was soluble in dilute nitric acid: I trust the following observation is somewhat newer than the above.

The red gas nitrogen trioxide, N_2O_3, has the power of re-kindling a glowing splint of wood or the glowing wick of a taper, just as oxygen or nitrous oxide would do.

The flame continues to burn with a bright but peculiar light, the red fumes disappearing.

The gas prepared by heating either starch or arsenious trioxide with nitric acid exhibits this property.

I am well aware that nitrogen *tetroxide* supports combustion, but I believe the above fact is new.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, February 28, 1871.

AUTOMATIC SPECTROSCOPE.

To the Editor of the Chemical News.

SIR,—My friend Dr. Huggins has recently described to the Royal Society (see CHEMICAL NEWS, vol. xxiii., p. 98) the very valuable little registering spectroscope devised by Mr. Howard Grubb, C.E., of this city, and lent by the latter gentleman to the Oran Eclipse Expedition. This instrument has been re-adjusted and supplied for use in my laboratory as an auxiliary to a very powerful spectroscope with automatic adjustment of prisms lately constructed for the Royal Dublin Society by Mr. Grubb. As some addition has been made to the registering spectrocope, which, in my opinion, renders it specially convenient for laboratory use, I will, with your permission, add a few words to the very interesting description of it given by the distinguished physicist who brought the apparatus under the notice of the Royal Society.

The slit, fitted to the spectroscope in the first instance, has been changed for one carrying a reflecting prism for the comparison of two spectra. A metallic cover encloses the whole of this part of the apparatus when not in use, so that the slit is completely protected from acid fumes.

Instead of employing a card on which to make the pricks in registering the positions of lines in a spectrum, I use a mica plate (of the size sold for covering *cartes de visite*). The mica plate is held securely in its position on the movable table of the apparatus, and two standard points marked at the beginning and end of a set of registrations. The relative positions of the lines are then read off by placing the mica plate over a graduated arc, decimally divided, on a silver plate, taking care to make the standard points on the mica always coincide with particular divisions of the scale. The scale I use is an arc graduated into 250 parts, beginning at the violet end of the spectrum. The measures of standard spectra obtained by this arrangement are entered finally on maps by means of a 250 m.m. scale. I should add that each division of the graduated silver plate corresponds to ten minutes of arc, and, of course, each millimetre on the map has the same value in angular measurement. While I much prefer the mica plates for use in recording observations, card slips can likewise be used, the graduated arc being then laid over the card register and the positions of lines read off. The spectroscope is now placed upon a strong metallic stand, on which it can be moved in a horizontal direction by loosening a small clamping screw. The instrument is now one of the most convenient of its kind I am acquainted with for general laboratory use, as very accurate observations can be made and recorded with its aid in a surprisingly short time.—I am, &c.,

J. EMERSON REYNOLDS, M.D.

Laboratory, Royal Dublin Society,
March 8, 1871.

DEVELOPMENT OF FUNGI IN POTABLE WATER.

To the Editor of the Chemical News.

SIR,—Will you permit me to correct one or two slight inaccuracies in your report of my remarks on Dr. Frankland's paper, and also to add one or two statements which I omitted to make at the time. With respect to charcoal filtration, I did not state that I had never found growths in the filtered water, but that on the large scale the first indication we had that the charcoal required re-burning or renewing, was that the filtered water produced these growths when mixed with sugar. This seems to me incompatible with Mr. Warington's suggestion, that new charcoal would impart phosphates to the water and so cause the growths to appear, whilst old charcoal would not do so, as, in fact, we begin to find them only after all soluble phosphate must have been long removed. I may here remark that it is a curious fact, that West Middlesex water, which may be mixed with sugar and kept for weeks without producing these growths, nevertheless seems to contain the germs in sufficient number to impart them to the charcoal, and, if permitted to accumulate, and perhaps grow in it, they are at last washed out by fresh water in number sufficient to produce growths rapidly, if treated with sugar. Dr. Frankland related how he aired a filter before passing water through it, but he did not tell us how long the charcoal had been under water before he did so, which is a point of great importance. When the large filter of which I have spoken was first put up, the water was kept constantly on it; for about three weeks the water was very good, but, at the end of five or six weeks, it was far worse than the unfiltered water, and no amount of airing put it right. The charcoal was then renewed, and one-half of the filter (which is in two compartments) was used for twenty-four hours, the other half was then put to work, while the first was drained and air passed through it for the next twenty-four hours, and so on. In this way the charcoal does its work well for about twelve months.

With respect to the rapidity of the growth and decay of the fungus, it seems to me to depend much on the proportion between the number of germs and the quantity of sugar which may be, to a certain extent, regarded as their food. If there be a large number of germs, a little sugar, the growth is rapid, and, when complete, breaks up so as to lose its distinctive character, but does not strictly disappear as stated in your report. If there be comparatively few germs in proportion to the sugar, they take longer to make an apparent growth, but go on increasing for a long time. When bacteria are produced in any large numbers, they very speedily destroy the fungus. In most of my experiments, but few of these animals appeared till long after the fungus was developed. I do not at all doubt that phosphorus plays an important part in the *development* of these germs, as Pasteur has shown that it does in that of all ferments, but, at present, I doubt their presence being so universal that the mere addition of a phosphate to any water will set them growing. I am now again at work on the subject, and hope shortly to have some results to communicate to the Chemical Society.—I am, &c.,

CHARLES HEISCH.

Middlesex Hospital.
Feb. 28, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Journal für Praktische Chemie, No. 1, 1871.

This number contains the following original papers:—

Hypobromite of Soda as a Reagent.—Dr. G. Hübner.—This very lengthy essay, illustrated with several woodcuts, treats on the use of hypobromite of soda for the purpose of decomposing ammonia and other nitrogenous compounds in such a manner as to make it possible to measure the gaseous nitrogen evolved, and hence lead to the quantity of ammonia or nitrogenous matter present in any compound. The author describes at length the following subjects:—Estimation of urea; action of the reagent on other amide-containing substances.

Improvements in the Arrangements of Chemical Laboratories.—Dr. H. Kolbe.—This paper treats of the ventilation, heating, and on the best plan for getting rid of the fumes of acids, and working with badly-smelling or irritating gases, especially sulphuretted hydrogen.

Constitution of Ultramarine.—W. Stein.—The first portion of a paper; we shall leave it until quite concluded.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 20, 1870.

This number only contains the account of the annual general meeting of this Society and the condensed report of its treasurer.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, January, 1871.

This number contains the following original papers more especially relating to chemistry:—

Poisoning with Hydrate of Chloral, and the Medical Treatment to be Employed in such Cases.—Dr. T. Husemann.—This paper contains an account of experiments made by the author to study the effect of chloral and its antidotes in animals, and also the record of some cases of poisoning which have happened.

Pulverised Iron Containing Copper. — Dr. Mirus. — This memoir treats on an adulteration, usually quite inadvertently made, of that preparation of pharmacy known as ferrum pulveratum, with metallic copper and other metals—lead, tin, antimony—precipitable from acid solutions by sulphuretted hydrogen, which reagent, according to the author, should not tinge in the least an acid solution of 4 grms. of the sample of pulverised iron to be tested.

Testing of Antimonial Preparations for Arsenic.—Dr. Von Ankum.—The author has instituted a comparative investigation of the various methods suggested for the detection of arsenic in antimonial preparations, especially in tartar emetic. The author's method is to ignite the antimonial preparation to be tested with four times its weight of pure nitrate of soda, to exhaust the residue with water, to acidulate the solution slightly with nitric acid, to concentrate by means of evaporation, and to add first nitrate of silver, and next, very carefully, some ammonia; the result being the formation of a more or less deep brown-red coloured precipitate, indicating the presence of arsenic, if present. The author states that, having taken only 10 grs. of tartar emetic, containing in that quantity less than half a milligramme of arsenic, he was enabled to detect the latter very readily by the method described.

Chloroform as a Means of Improving the Taste of Cod-Liver Oil.—Dr. Hager.—The author states that the addition of ten drops of chloroform to 100 grms. of cod-liver oil render that fluid perfectly agreeable and palatable to take, without in the least impairing its good quality, or interfering with its effect on the human frame.

Polytechnisches Journal von Dingler, first number for January, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Utilisation of Peat.—Dr. Dingler.—An account of the manufacture of good fuel from peat, as carried on in some parts of Bavaria, with full statements of cost and profit.

Testing the Genuineness of Silver Plating on Metals.—Dr. Böttger.—A cold saturated solution of bichromate of potassa in nitric acid (sp. gr. 1·2) is taken, and applied to the metallic surface to be tested, after having been previously cleaned with strong alcohol, in order to remove dirt, fatty matter, and especially any varnish. A drop of the test fluid is then applied to the metallic surface by means of a glass rod, and immediately afterwards washed off with some cold water. If pure silver is present (as regards silver coins, these are left in contact with the test fluid for a greater length of time) there will appear clearly a blood-red coloured mark (chromate of silver). Upon German silver the test liquid appears brown, but after washing with water the blood-red coloured mark does not appear; the so-called Britannia-metal is coloured black; on platinum no action is visible; metallic surfaces coated with an amalgam of mercury yield a reddish speck, which, however, is entirely washed off by water; on lead and bismuth the test liquid forms a yellow-coloured precipitate; zinc and tin are both strongly acted upon by this test liquid, which, as regards the former metal, is entirely removed by water, while, as regards the latter, the test liquid is coloured brownish, and addition of water produces a yellow precipitate which somewhat adheres to the tin.

Second Number for January, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied substances:—

Researches on a Graphite from Styria.—J. Stingl.—The raw material here alluded to exhibited a coarsely foliated structure, strong metallic lustre, sp. gr. 2·1443. 100 parts of the substance were, on analysis, found to contain—Carbon, 82·4; silica (belonging to the ash), 12·38: alumina, 3·9; peroxide of iron, 0·53; proto-sesquioxide of manganese, 0·62; lime, 0·02; and traces of alkalies. A sample of the quartz imbedded in and interspersed through the graphite was also analysed and found to contain, in 100 parts—Silica, 99·20; peroxide of iron, 0·46; alumina, 0·12.

Contribution to our Knowledge of the Chemistry of the Blast Furnace, being an Appendix to the Papers on the Blast Furnace, by T. Schins.—From a foot-note added to this exhaustive essay, we learn that this paper will shortly be published in full in English.

Interposition Scale for the Spectroscope.—Dr. J. Müller.—A lengthy essay, illustrated by woodcuts and engravings.

Experiments on the Making of Malt without Germination.—Dr. H. Fleck.—This essay contains the detailed account of a series of experiments made by the author, with the view to ascertain how far it is possible to substitute for the ordinary process of malting the method of steeping the grain (barley or any other) desired to be converted into malt, in weak and dilute acids, to obtain thereby the same effect as produced by germination, and, moreover, in a far shorter period of time. It appears that, provisionally, the author has succeeded in his attempt, but is engaged in further experiments. Dilute nitric acid, containing 1 per cent of acid, yields excellent results.

Annalen der Chemie und Pharmacie, January, 1871.

This number contains the following original papers and memoirs:—

Dissociation of Caffeidine by Hydrate of Baryta.—F. Rosengarten and A. Strecker.—After first stating that, by treating caffeine some years ago with baryta, they obtained caffeidine, according to the following formula:—

$$\underbrace{C_8H_{10}N_4O_2}_{\text{Caffeine.}}+H_2O=\underbrace{C_7H_{13}N_3O}_{\text{Caffeidine.}}+CO_2;$$

while, at the same time, methylamine, ammonia, and some other not yet defined substances, were formed. The authors treat, in this paper, on the action of hydrate of baryta upon caffeidine, alluding thereby, in the first place, to Dr. Schultzen's researches on this subject, published in the *Zeitschrift für Chemie*, 1867, p. 614. It appears, from the researches made by the authors above named, that caffeidine is, by boiling with water and hydrate of baryta for forty hours continuously, slowly converted into sarkosine; and the formula of dissociation for caffeine is—

$$C_8H_{10}N_4O_2+6H_2O=2C_2O_4+2NCH_5+CH_2O_2+C_3H_7NO_2.$$

Compounds of Strychnine-Oxethyl.—Dr. R. Messel.—This paper treats on the following substances:—Sulphate of strychnine-oxethyl, a crystalline body readily soluble in water, also soluble in boiling alcohol, but separating therefrom on cooling. Hydrate of strychnine-oxethyl is obtained from the chloride of the base by treating it with excess of oxide of silver; the hydrate is precipitated by chloride of platinum, yielding a compound—

$$\begin{matrix}CH_2\\ \|\\ CH.N(C_{21}H_{23}NO_2)Cl\end{matrix}+PtCl_2,$$

containing 17·4 per cent of platinum.

Sulpho-Maleic Acid.—Dr. R. Messel.—This very lenghy essay contains the following sections:—Neutral sulpho-maleate of potassa, $C_4H_2K_2SO_7+H_2O$. Acid sulpho-maleate of potassa. Neutral sulpho-maleate of lead, $C_4H_2Pb_2SO_7$, containing 61·43 per cent of lead; lime, baryta, and silver salts of the acid. Products of the action of fusing caustic potassa upon the acid—viz., maleic and fumaric acids by the elimination of SO_3+H_2O, and succinic acid by elimination of sulphurous acid. Sulpho-succinic acid.

Some of Products Derived from Asparaginic Acid.—Dr. E. Schaal.—This memoir is divided into the following chapters:—Preparation of asparagine from asparaginic acids; by a lengthy and circuitous process, first the ether of asparaginic acid, and from that ether, by the action of ammonia thereupon, asparagine is obtained. Action of hydrochloric acid (the dry gas), at a high temperature, upon asparagine. Copper salts from asparaginic acid. Optical behaviour of asparaginic acid.

Pyro-Sulpho-Uvic Acid.—Dr. T. Wieland.—The formula of the hydrate of the acid alluded to, as deduced from the formula of the calcium salt, is—

$$C_5H_3\begin{cases}COOH\\ SO_3OH\\ COOH\end{cases}$$

the formula of the pyro-uvic acid being—

$$C_5H_6\begin{cases}COOH\\ COOH\end{cases}$$

The paper, which contains a series of formulæ, winds up with a chapter on the products of decomposition of the sulpho-acids when treated by fusing caustic potassa.

Compounds of some of the Aldehydes and Amides.—Dr. L. Medicus.—This exhaustive memoir contains the following sections:—Action of oenanthal upon benzamide; action of oenanthal upon nitro-benzamide; action of essential oil of bitter almonds upon oxamide and oxamethan.

Compounds of Aceto-Piperidine.—Dr. K. Kraut.—This essay treats on—Oxyhydrate of aceto-piperidine, $C_7NH_{13}.O_2$, a substance readily soluble in water, crystallising in colourless rhombic-shaped crystals, difficultly soluble in alcohol. Compound of oxide of copper and oxyhydrate of aceto-piperidine, $Cu.2(O.C_7NH_{13}O)$, a beautifully blue-coloured crystalline body, readily soluble in water. Chloride of aceto-piperidine, $Cl.C_8H_{16}.HN.CH_2.CO.O.H$, a compound which combines with chloride of gold, forming the combination—

$$3(HCl,AuCl_3),4C_7NH_{13}O_2,$$

also a crystalline substance soluble in water. Chloride of barium aceto-piperidine, $C_{17}NH_{13}O_2,BaCl_2$.

Preparation and Composition of Hyoscyamine.—H. Hoehn and E. Reichardt.—This very lengthy and exhaustive essay is divided into the following chapters:—Preparation of hyoscyamine; hyoscyamine (this portion contains the detailed description of the properties, reactions, salts, and some of the products of decomposition of this alkaloid; the formula of hyoscyamine is stated to be $C_{20}H_{28}NO_3$); dissociation of hyoscyamine; hyoscinic acid, $C_{12}H_{16}O_6$; hyoscine, $C_{12}H_{13}N$.

Description of an Apparatus for Exhibiting the Formation of Water.—Dr. F. Wöhler.—Accompanied by a woodcut necessary to the proper understanding of the description.

NOTES AND QUERIES.

Watering the Streets with Salts.—Could you kindly inform me if Mr. Cooper has a patent for the above, and, if so, what is the date of it?—C. T.

Laughing Gas.—(Reply to "Reader.")—You must have used an aqueous solution of the gas; for, although the nitrous oxide gas may be liquefied by pressure or cold, it is impossible that it should be for sale in that state, unless in small quantity in strongly-made sealed glass tubes, since the liquefied gas boils at $-88°$, and at $+7°$ exerts a pressure of 50 atmospheres (750 lbs. to the square inch). The gas, if prepared with due care from pure materials, will have a different effect and properties from those you mention.

Tar Distilling.—(Answer to "Tar Distiller.")—It is the presence of ammonia-water amongst the tar which causes the latter to froth up and boil over in the stills, although a moderate degree of heat be applied, and even that gradually; the danger never ceases till almost all the ammonia-water has come over, and it is greater the larger the amount of this water present in the tar. The reason, then, that it is found at times that the stills will inevitably boil over, and that there is scarcely any possibility of preventing it, is that the men, in charging, have run more water in with the tar than usual. The best means of separating the two bodies (the tar and the water) is, I believe, as follows:—The tar and ammonia-water are emptied together from the barrels into one well, in which the two separate, the ammonia-water being in the upper layer of fluid, and the tar, holding a considerable amount of water in suspension, in the lower. There ought to be a tank elevated on brick-work, so high that the bottom thereof shall be level with the man-holes of the tar stills; and this tank should be sufficiently large to hold, at the least, a charge fully sufficient for the largest still, so as to preclude the necessity of re-filling. If possible, it would be most convenient to have the tank of such capacity that it would contain two or three charges of tar, but they must be full charges (*e.g.*, no fraction of a charge left). The tank is to be furnished with tap and 3-inch bore pipe, leading to the man-holes of the stills. The tar is now to be pumped from the well, by a pump whose pipe dips nearly to the bottom of the layer of tar, into the tank above, and there it should stand, at least twelve hours, if possible more, before running into the stills. By this means the water held in suspension by the tar has time to rise, and will be found, after the above-mentioned lapse of time, to be floating in a thin layer on its surface. It is impossible thus to separate all the water, but *it is* possible to separate such a portion thereof that the distillation of the tar may be rendered practicable. Of course, even after taking these precautionary measures, the greatest care is still requisite in commencing operations, and till, in fact, all the crude benzol has ceased to come off.—Watson Smith, F.C.S., Prestolee Alkali Works, near Manchester.

MEETINGS FOR THE WEEK.

Monday, 13th.—Medical, 8.
—— Geographical, 8.30.
—— London Institution, 4. Mr. R. A. Proctor, B.A., F.R.A.S., "On Astronomy."
Tuesday, 14th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
—— Photographic, 8.
Wednesday, 15th.—Society of Arts, 8.
—— Meteorological, 7.
—— London Institution, 6.30. Conversazione. Mr. Henry Holiday, on "Stained Glass Æsthetically Considered with Reference to Modern Art."
Thursday, 16th.—Royal, 8.30.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Royal Society Club, 6.
—— Chemical, 8.
Friday, 17th.—Royal Institution, 9. J. Norman Lockyer, F.R.S., "On the Eclipse."
Saturday, 18th.—Royal Institution, 3. Mr. O'Neil, "On the Spirit of the Age."

TO CORRESPONDENTS.

A. Barfoot.—We are unable to give our correspondent a formula for making soaps in imitation of Gossage's soaps.

Subscriber.—We cannot insert queries about price, &c. of ordinary chemicals; almost any wholesale house would supply the article you want.

Dr. Cameron.—The journal was at press when your letter came.

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London: Chemical News Office, Boy Court, Ludgate Hill, E.C.

THE CHEMICAL NEWS.

VOL. XXIII. No. 590.

THE TAILS OF COMETS, THE SOLAR CORONA, AND THE AURORA, CONSIDERED AS ELECTRIC PHENOMENA.*

By Professor OSBORNE REYNOLDS, M.A.

PART II.

IN the paper which I read before this society, on the 29th of November last, I endeavoured to show that it is probable that these phenomena are a species of that action known as the electric brush taking place in the medium which fills space, be it ether or simply gas, or both. The reasoning I made use of was, essentially *à fortiori*. I pointed to the fact that the electric brush as seen in the Geissler tubes exhibits similar appearances, and that at the times of greatest display on the part of comets and the aurora similar conditions are present, such as a change in the action of the sun, conditions which, to say nothing more, are favourable to electric disturbance. I purposely avoided all attempts to explain how the brush may be produced, feeling that it was sufficient to point to the aurora, which is universally admitted to be electrical, as a proof that such phenomena do exist even if we cannot explain how. This proof, however, is perhaps not quite satisfactory. In order that it may be complete, the other phenomena must be produced in the same way as the aurora, and this, although possible, is not necessary. An assumption which is commonly made respecting the phenomena of the aurora cannot be made with respect to the others. This assumption assigns the two magnetic poles of the earth as the the two electrodes between which the electric discharge takes place, which forms the aurora borealis and the australis. If this assumption be maintained, some other explanation must be found for the manner in which electricity may form the tails of comets and the corona. It is quite clear that the tail of a comet cannot be due to a discharge between two electrodes situated on the comet itself. In the same way, from the position occupied by the corona, it can hardly be due to electricity passing between two electrodes on the sun. In fact, if a comet's tail is electrical, it is due to a discharge of electricity of one kind or another from the comet, which, for the time, answers to one of the electrodes only. The same may be said of the corona and the sun. If we could observe the aurora from a point distant from the earth, it is very probable that we should find the same to be the case, but whether this would be so or not, an assumption has been made as to the cause and nature of the aurora, which will answer just as well for the corona and comet's tails; it is that the sun, acting by evaporation or otherwise, causes continual electric disturbance between the earth and its atmosphere, the solid earth being negatively charged and the atmosphere positively, and that the aurora is the reunion of these electricities taking place in the atmosphere.

Now, as has been already said, this assumption will serve for the comets and the sun as well as for the aurora. If there is a continual electric disturbance between the sun and the medium in which it is placed, so that the sun becomes negatively and the medium positively charged, the reunion of these electricities would form the corona. It must not be supposed that I assume the sun to be a reservoir of electricity which it is continually pouring into space. I consider that the supply of electricity in the sun is kept up by some physical action going on between the sun and the medium of space, whereby the sun becomes negatively charged, and the medium positively.

This may be well illustrated by reference to the common electrical machine; here the motion of the glass against the rubber causes the glass to become positively and the rubber negatively charged; and these electricities do not unite instantly there and then, but remain and accumulate in the respective bodies, until collected and brought together again by the conductor.

Assume, then, that the sun is in the position of the rubber, while the ether is in that of the glass: then the corona corresponds to the spark or brush which leaves the conductor. On the same assumption, the negative electricity of the comet would be more and more set free by the inductive action of the sun as the comet approached it, and would also be driven off by induction in a direction opposite to that of the sun; and combining with the positive electricity in the ether would form the tail of the comet, in a manner analogous to that in which a negative spark is given off by the lid of the electrophorus.

I think that a rational account may in this way be given of the manner of the electrical action to which I have attributed these phenomena, but I do not consider that the probability of the truth of this electrical hypothesis depends on the value of such an explanation. It is an assumption based on the manner in which it fits into its place, and explains the appearances presented by these beautiful phenomena.

Since this paper was written, my attention has been called to the fact that Mr. Richard Proctor has published views of these phenomena which somewhat resemble mine. He attributes them in part to electricity and in part to meteors. There is, however, this fundamental difference between our views, that he considers the tails of comets as consisting of cometary matter, the difficulty of conceiving which was the origin of these speculations. Moreover, I can conceive no electric discharge between two meteors without a medium, between them, and if there is a medium, why is there any necessity for meteors? If, as I see good reason to suppose, gas, when glowing with electricity, reflects or scatters rather than and absorbs light of the wave-length which it radiates, that portion of the coronal light, which is polarised and assumed to be reflected, will be accounted for. I think that the recent observations have confirmed the probability of these speculations, inasmuch as they have confirmed the facts on which these speculations were based. There is one point which has not been already noticed, but which seems to me to be of some importance.

If the corona be an electric discharge, the electricity will be continually carrying off some of the elements of the sun into space where they will be deposited and condensed. May not this stream of matter be the cause of the existence of small meteors, and supply the place of those which continually fall into the larger bodies?

* Read before the Manchester Literary and Philosophical Society, February 7th, 1871.

ON KREOSOL AND PHENOL AND THEIR HOMOLOGUES.

By PAUL SCHWEITZER, Ph.D.

IN the year 1832 a body was discovered by Reichenbach, in the distilled oils of beech-wood tar, which, on account of the peculiar property it possessed of preserving meat and other highly-organised substances, was called by him kreosot. This substance attracted the attention of many chemists, who studied its properties, and sought to separate it from tar oils in general, and it was with a degree of satisfaction that two years later F. F. Runge announced his discovery of a creosote in coal-tar oil, which he called carbolic acid. Reichenbach, fearing his right of the first discovery infringed by this carbolic acid, which, according

* Read before the Lyceum of Natural History of New York.

to Runge, differed slightly from his compound, tried to demonstrate, for his own glorification, the identity of both substances; and though Laurent, in the year 1841, proved carbolic acid to be phenylic hydrate, and pronounced it a different body from creosote, Reichenbach did not give up the contest, but conducted it with a pertinacity which caused a general confusion among chemists—a confusion which became quite lamentable when, in 1855, cresylic hydrate was discovered in coal-tar by Pairlic, and which, on account of the near resemblance to true creosote, was generally accepted to be identical with the original compound obtained from beech-wood tar.

Many chemists have given their attention since then to the study of those two compounds, but carbolic acid very shortly after its discovery began to be introduced in commerce and sold as creosote. It was difficult, and at times impossible, to procure the oils made from wood-tar; and it was owing to this that the publication of some chemists are found to be at variance in their results, as they were, in fact, working with carbolic acid, while speaking of creosote. Hlasiwetz and Gorup-Besanez, among many others, have now cleared up the questions, and brought light and intelligence into the many contradictory statements which we find in the literature of creosote and carbolic acid. We know to-day that two homologues are contained in that part of the oil of wood-tar which dissolves in caustic potassa, and which bear a certain relationship to the compounds obtained from the same part of the oil obtained from coal-tar. We are justified in saying that those oils are two distinct and different fluids; for while coal-tar oil contains principally—

Phenylic hydrate, C_6H_6O, and
Cresylic hydrate, C_8H_8O;

wood-tar oil contains—

Guaiacol, $C_7H_8O_2$, and
Kreosol or Homo Guaiacol, $C_8H_{10}O_2$.

I intended saying here a few words about the place we have to assign those compounds in organic chemistry, and about their constitution, before giving the differences by which one class may be distinguished from the other. Phenylic and cresylic hydrate belong to a class of compounds the radicals of which differ by the complex CH_2. They are probably very numerous, and of those that are known I will only mention—

Phenyl, C_6H_5
Benzyl, C_7H_7
Xylyl, C_8H_9

The name of xylyl is at present somewhat obsolete, and phloryl is substituted for it. In combination with hydrogen those radicals form—

Phenylic hydride, C_6H_6 or benzol,
Cresylic hydride, C_7H_8 or toluol,
Phlorylic hydride, C_8H_{10} or phloruol (xylol);

the alcohols of them are—

Phenylic hydrate, C_6H_6 or phenol,
Cresylic hydrate, C_7H_8O or kresol,
Phlorylic hydrate, $C_8H_{10}O$ or phlorol (Würtz, xenol).

In treating these alcohols with oxidising substances, we obtain, at least in the case of phlorol, substances which contain more oxygen and less hydrogen than the alcohols, and which we call—

$C_8H_8O_2$.	$C_7H_6O_2$.	$C_6H_4O_2$.
Phloron.	Kreson.	Chinon.

I said in the case of phlorol; for, though we are able to produce the other two compounds, the first by heating chinic acid, which, in combination with lime, is a constituent of all Peruvian barks, and the second by decomposing kresol, we will, no doubt, in time arrive at a proper method for obtaining them all directly, by treating the alcohols with nascent oxygen.

In subjecting gum guaiac to destructive distillation, we obtain a fluid which, in many respects, bears a great resemblance to creosote. This distillate has been investigated especially by Völckel and Lobrero, and Hlasiwetz, who succeeded in separating it into two fluids that gave crystallisable compounds with bases, and which they called guaiacol and homo-guaiacol. A later and closer study of creosote revealed the fact that it consisted of those two identical compounds in different proportion. Let us compare them with the products we obtained from the alcohols of the phenylic series—

$C_6H_4O_2$ (chinon). $C_7H_6O_2$ (kreson).
$C_6H_6O_2$ (hydrochinon and pyrocat.) $C_7H_8O_2$ (guaiacol).
$C_8H_8O_2$ (phloron).
$C_8H_{10}O_2$ (homo-guaiacol or creosote.)

But we have also the member corresponding to the chinon in a compound called pyrocatechin, thereby completing two series of compounds, which differ only by the addition of two equivalents of hydrogen. If we treat chinon with hydrogen, we obtain directly hydrochinon; the attempt made in this direction with the others succeeded perfectly, so that we possess another series of homologues—

Hydrochinon
Hydrocreson
Hydrophloron

of exactly the same composition as—

Pyrocatechin
Guaiacol
Kreosol

but different in properties.

Now let us look at the constitution of those compounds. It is very probable, and almost admitted by Kekulé, that kresol is monomethylated phenol, and phlorol bimethylated phenol. In the same way, may we feel entitled to consider guaiacol monomethylated pyrocatechin and kreosol bimethylated pyrocatechin; in fact, in treating guaiacol with hydriodic acid, we obtain iodide of methyl and pyrocatechin, which amounts to a proof of this view, and which gives us, therefore, two links, by which we may connect the series of coal-tar oils with those of wood tar. To render it apparent to the eye, I will give the formulæ as follows:—

$C_6H_6(OH)$ (phenol.) $C_6H_5(OH)$ (pyrocatechin).
$C_6H_4\begin{cases}OH\\CH_3\end{cases}$ (kresol). $C_6H_4O\begin{cases}OH\\CH_3\end{cases}$ (guaiacol).
$C_6H_3\begin{cases}OH\\CH_3\\CH_3\end{cases}$ (phlorol). $C_6H_3O\begin{cases}OH\\CH_3\\CH_3\end{cases}$ (kreosol).

It may be stated, as a further proof for the correctness of considering the above compounds as methylated pyrocatechin, that the molecule of methylene, CH_3, may be introduced directly into the constitution of pyrocatechin, by heating it in closed tubes with caustic potassa and methyl-sulphate of potassa, producing thereby guaiacol.

The homologues of the phenylic series are crystallisable compounds, of the respective boiling-points of 184° C., 203° C., 220° C., while the two derivatives of pyrocatechin are oily liquids boiling at a temperature of 200° C. and 219° C.

Phenol,	184° C.	Pyrocatechin	—
Kresol,	203° C.	Guaiacol,	200° C.
Phlorol,	220° C.	Kreosol,	219° C.

It may be seen, therefore, that in cases of working with a mixture of the individuals of both series, we should find it impossible to separate them by fractional distillation. Their products of decomposition, however, may be resorted to as a means of distinguishing between them. For, while phenol and its series yields, with nitric acid, nitrophenol and similar compounds, we obtain with guaiacol oxalic acid; chlorine converts phenol into chlorophenic acid and choranil, while the products obtained in this way from creosote, though similar to them, present differences which stamp them as peculiar and distinct bodies.

THE TOWNSHEND JEWELS.

By A. H. CHURCH, M.A.

Much scientific as well as artistic interest centres about many of the minerals which have been used for purposes of ornament. The study of the intruding substances and the cavities often occurring in quartz, ruby, and topaz, has led to the discovery of many singular facts, and has partially lifted the veil which shrouds from curious eyes the origin of some of the most beautiful products of the earth. So also the crystalline forms and optical properties of precious stones, together with the action of heat and other forces upon them, have afforded ample and profitable materials of research for the mathematician and the physicist. Thus it would be easy to vindicate the claims on scientific consideration which jewels possess. Were we to travel for a moment out of the path which we intend to follow in the present notice, and to speak of the artistic qualities of precious stones, we should have a rather difficult task to accomplish, for, strange to say, it has become usual, amongst a certain clique of artists and connoisseurs, to depreciate their beauty. Professor Ruskin*, for example, talks of the colours of gems as "entirely common and vulgar;" he calls the green of the emerald as "vulgar as house-painting," and states (what is absolutely incorrect) that "no diamond shows colour so pure as a dewdrop." "The ruby," he adds, "is like the pink of an ill-dyed and half-washed-out print compared to the dianthus." Other writers on art, ignorant of those wondrous properties of jewels which are developed only by judicious cutting, would not allow a specimen to be facetted, but simply rounded and polished in the way known as *en cabochon*. Our present purpose, however, is not to offer a logical justification of the fondness for precious stones, which most people exhibit to some degree, but to direct the attention of our readers to the superb suite of specimens which has been recently bequeathed to the nation by the late Rev. C. H. Townshend. The collection is to be seen in the South Kensington Museum, and is, or was recently, in one of the picture galleries. A catalogue† of the specimens has been published under the auspices of the Science and Art Department, but, unfortunately, it is in many points an inadequate production; for ease of reference it will, however, be expedient to follow the order in which the specimens are therein described.

A fine large crystal of diamond (No. 1172) affords an example of the peculiarly brilliant lustre which distinguishes even the natural surfaces of this stone, and permits anyone who appreciates its character to single out a rough diamond from all other stones. The specific gravity of the diamond (3·53) does not enable us to distinguish it from glass or white topaz with certainty, though it separates it from white quartz, which is only 2·65, and white beryl, which is only 2·71. There is a black diamond (No. 1173) in the collection, which displays on its facets the characteristic lustre of the stone. A colourless diamond of pure water, and about 5-12th of an inch across, is a splended brilliant from the Hope collection. A lustrous yellow diamond of the same size should also be noticed. Of other coloured diamonds there are two green specimens, one of a pale blue hue, one of a curious and very rare puce tint.

It will not be necessary to dwell upon the peculiarities of any of the many forms of silica represented in the collection. Almost all the ordinary and most of the rare varieties may be here seen mounted in rings, and, in some cases, set off by borders of diamonds. One amethyst (1187) is remarkable for containing several cavities partially filled with fluid. Some of the translucent specimens known as *cat's-eye*, of a yellow or brown colour, are good examples of the peculiar "chatoyant" effect produced by regularly disposed asbestos filaments penetrating the quartz. Several of the specimens catalogued under the heading Silica belong, however, to far more *récherché* species. One, for instance (No. 1188), is probably a pink topaz, and not an amethyst; another, called burnt quartz (No. 1194), appears to be a splended chrysoberyl, the dispersive power of the stone being far too high for silica. Burnt quartz is the name given (after strong heating) to a dark variety of rock crystal from Portugal and Brazil, which assumes, after having been submitted to a high temperature, a sherry-brown or red colour.

Of opals there are more than a dozen in the Townshend collection; many of them exhibiting the most superb play of prismatic colours. One is pale grey, and shows a fine blue iridescence.

The sapphires and rubies include a series of fine specimens of the highly-prized deep velvet blue, and the pigeons'-blood red colours. There are also some violet and salmon-coloured corundums of great rarity and beauty. A golden-yellow one, of great brilliancy (No. 1312) is included with the topazes. The star-rubies and star-stones are well represented. These stones somewhat resemble the cat's-eye, but they show a six-rayed star, which is best seen when the gem, cut across its axis, and left with its top *en cabochon*, or rounded, is principal viewed in sunlight or in the focus of a condensing lens. In the case of these star-stones, the internal reflection is due, not to intruding substances, but the mode in which the crystal has been built up of symmetrically disposed but not perfectly regular layers.

The turquoise comes next in order. The true turquoise is a phosphate and hydrate of aluminium coloured by a little phosphate of copper. The false, or bone turquoise, is merely fossil ivory tinted with phosphate of iron, not phosphate of copper, as stated in the catalogue,

Several of the most beautiful varieties of garnet are seen to perfection in the Townshend series. Two of the specimens (1306, 1307) are wrongly labelled "jacynth," included under the heading zircon in the catalogue. One of the so-called garnets, of an amethystine colour, seems likely to belong to another species.

A fine inscribed emerald, from the celebrated collection of the late H. P. Hope, is the first beryl in the list. It is of rich colour, and nearly ¾ inch by ¾ inch in dimensions. Another stone (No. 1284), though smaller, is a still finer specimen, faultless in cutting, shape, and colour, and almost half an inch across. The aquamarines in the collection are of immense size and rich hues. One of them presents almost the exact tint of the more valuable blue topaz.

Nine specimens are catalogued as chrysolites, but at least four of these are incorrectly assigned to this species, Nos. 1297 and 1304 are chrysoberyls, while 1304 is a zircon of the variety known as jargoon.

The white topaz is not well represented in the collection, and there is great confusion amongst the coloured varieties of this stone. No. 1309 is much more like a spinel than a topaz, while No. 1312 is a splended yellow sapphire. No. 1318 seems only quartz.

Of the five stones labelled as tourmalines, one (No. 1322) is certainly a jargoon. The green tourmaline (Nos. 1321, 1323) is a beautiful but not brilliant stone. A peculiar interest attaches to this species, owing to its optical characters. It is a striking instance of dichroism, the rich grass-green specimens being perfectly opaque when viewed along instead of across the principle axis of the crystal.

Among the spinels is one of an indigo-blue colour (No. 1325), and two fine pink-coloured specimens.

There is a splended suite of chrysoberyls, although some of them are incorrectly included under quartz and chrysolite. The precious cat's-eye, or cymophane, is a variety of chrysoberyl. Its opalescence is due to its intimate structure, and only appears when the light is incident at a particular angle. The line of light should be straight and clear as silver wire, and shows to the best advantage when the stone is of a clear green tint.

We have not space to record the peculiarities of the remaining species represented in the Townshend gift.

* Ruskin's Lectures on Art, pp. 176 and 177. (1870).

† Catalogue of Gems and Precious Stones (Townshend Bequest), by J. Tennant. 1870.

There are moonstones and sunstones, with examples of labradorite, kyanite, and pyrite, all gorgeously mounted in gold coronet rings, and in many instances set off by rows of diamonds. We have merely noticed the existence of this very interesting and valuable collection in the hope that it may receive that attention at the hands both of artists and mineralogists which it deserves. The names assigned to about twenty of the specimens should be revised, and then we should possess in London three fine suites of authentic precious stones, from which their characteristics might be readily learnt. The other two public collections are in the British Museum and in the Geological Museum of Jermyn Street. It is greatly to be desired that the specific gravity, hardness, crystalline system, and refractive and dispersive power should be noted on the label of each specimen.

PRELIMINARY NOTICE ON THE

PRODUCTION OF THE OLEFINES FROM PARAFFIN BY DISTILLATION UNDER PRESSURE.*

By T. E. THORPE, Ph.D.,
Professor of Chemistry in Anderson's University, Glasgow,
and JOHN YOUNG.

WHEN paraffin is exposed to a high temperature in a closed vessel, it is almost completely resolved, with the evolution of but little gas, into hydrocarbons which remain liquid at the ordinary temperature.

This reaction will undoubtedly afford the most important insight into the constitution of this body.

Accordingly we have repeated this conversion on a large scale, and from about 3½ kilogrms. of paraffin melting at 44·5° C. (prepared from shale), we have obtained nearly 4 litres of liquid hydrocarbons. This mixture of hydrocarbons commences to boil at about 18° C., but the quantity coming over below 100° C. is comparatively small; by far the greater portion boils between 200° and 300°. A preliminary separation shows that the 4 litres are made up of hydrocarbons boiling—

	Litres.
Between 200° and 300°	2·7
,, 100° and 200°	1·0
Below 100°	0·3
	4·0

Up to the present time, we have principally occupied ourselves with the investigation of the fraction boiling below 100°, and have obtained conclusive evidence that it is mainly composed of olefines, the proportion of members of the $C_nH_{2n}+2$ series being but small. By repeated fractionations over sodium, we obtained perfectly colourless liquids, boiling at about 35° and 65°, which were attacked by bromine in the cold with the greatest energy. On adding the bromine slowly, and in minute drops, and carefully cooling the hydrocarbon by a mixture of snow and salt, scarcely a trace of hydrobromic acid was produced. The portion boiling at 36° may be either amyl hydride or amylene, or a mixture of both; the avidity with which the bromine combines with it shows that the latter body must be present in considerable quantity. As soon as the drops of bromine permanently coloured the liquid it was submitted to distillation. Only a small portion came over below 40°; the thermometer rose rapidly to 180°, and nearly the whole of the bromine-compound distilled at 184° to 188°. This substance is amylene bromide, $C_5H_{10}Br_2$; Wurtz gives the boiling-point of this body at about 180°. The portion, therefore, boiling at 35° is mainly amylene.

Exactly similar results were obtained from the portion boiling at 65° to 70°. This, from its boiling-point, may be either C_6H_{12} or C_6H_{14}, or a mixture of both. Bromine disappears instantly on adding it to the carefully-cooled liquid, and on distillation by far the greater portion is found to have combined with the halogen. The bromide thus obtained distils, with slight decomposition, at about 195°. Pelouze and Cahours found that hexylene bromide, $C_6H_{12}Br_2$, boiled at 192° to 198°.

We are at present engaged in the further investigation of this subject, and hope shortly to lay our results before the Royal Society.

* Read before the Royal Society, March 9th, 1871.

FURTHER EXPERIMENTS ON THE EFFECTS OF COLD UPON CAST-IRON.*

By PETER SPENCE, F.C.S., &c.

IN resuming these experiments upon the effects of cold on cast-iron, it is not necessary for me to say that I was led to resume them from the apparent undecisiveness of all the experiments brought before the Society some time ago, my own being included in that category, none of them being so free from possible sources of error as to be fitted for finally settling the matter.

In the experiments which I have now to bring before the Society I have limited my aim to a single point, namely, as to whether the reduction of temperature has any, and if so, what, effect on cast-iron in regard to its powers of resisting transverse strain either of weight or pressure, and it appears to me that if this point can be satisfactorily settled it will go a long way in settling the other points now in dispute.

As my object, in showing that I have in these experiments eliminated, as far as seems possible, all sources of error, will be best effected by minute detail, you will excuse anything that may seem trifling. As I was not trying the absolute strength of any sort of cast-iron I did not see the force of Mr. Brockbank's objection to my using ½-inch bars instead of the orthodox 1-inch bars. I could obtain ½-inch bars equally good castings, and the machinery for breaking them was more manageable and in my opinion more exact.

Messrs. Rye, Son, and Ogden, of Newton Heath, kindly undertook to make for me fifty bars, each 3 feet long by ½-inch square, all out of one ladle, and of No. 3 Glengarnock pig and Kirkless Hall common pig—I name these although it does not seem of importance; all I wanted was good, sound, clean, and equal castings; and knowing the purpose for which they were intended, with great care they turned them out so good that not one of those sent to me was rejected. I now cut each of these bars into three lengths of 1 foot each, and as they were cut they were thrown into a heap, making nearly 150 pieces. They were now taken and all their ends covered with paint, in order that the new fracture might be examined as they were broken. The heap was then brought into the laboratory, having thus had three chances of perfect mixing. A boy of eleven years of age now handed me the pieces singly from the heap, and as I received them I placed them alternately one by one in two lots, until I had got seventy pieces in each lot. One of these was now taken and put into a cask capable of holding 2 cwts. to 3 cwts. of freezing mixture composed of pounded ice and chloride of sodium (which instantly reduces the temperature to zero), and being surrounded with sawdust, they were kept there for nearly forty-eight hours.

The other seventy were now put into water at 70° F. and this was done chiefly in order that they might be broken wet, as those would necessarily be when taken out of the freezing mixture.

The mode of breaking was this:—I put a bar on the suspending wedges, then hooked on the weight scale, and with a number of weights much under the breaking load, raised the loose end of the plank by the screw-jack so as to bring the weights to bear. I now added single pounds

* Read before the Manchester Literary and Philosophical Society, February 7th, 1871.

or 2-lb. weights till 15 lbs. were put on; these were then taken off and a 14-lb. weight was placed and single pounds again put on, thus regularly adding till the bar snapped; I then recorded the breaking weight, my assistant meantime putting on another bar. I spent nearly eight hours in breaking these seventy bars, and every one got an equal amount of care.

On opening up the freezing mixture forty-four hours after enclosing it, I found it in perfect condition, little solution and no increase of temperature having taken place. The bars were taken into the laboratory in small lots and immersed in another freezing mixture, from which they were withdrawn singly with pliers. Having seized one piece with too firm a grasp I found that my fingers grew white and produced an intense pain as if burned. Some of the freezing mixture was spread on each bar by a spatula while on the machine, so that every one was broken at a temperature within one or two degrees of zero.

The mode of breaking was exactly similar to that employed with the other lot, and equal care was given to every bar. This I can affirm, as every one of them was broken by myself, and all entries made by myself.

The results are before you, and to me it was a matter of surprise, when both sets were completed and added up, to find that they almost exactly corroborated my previous experiments, which I do not think were fallacious in their character, but merely defective in their not covering a sufficient amount of ground to give certainty to the result. I have, however, so much confidence in those now detailed that I have no hesitation in giving it as an ascertained law, that a specimen of cast-iron having at 70° F. a given power of resistance to transverse strain, will on its temperature being reduced to zero, have that power increased by 3 per cent.

Breaking-Weight of ½-inch Square Cast-Iron Bars, 9 inches between Points of Suspension at 70° F.

	Cwts.	Qrs.	Lbs.		Cwts.	Qrs.	Lbs.
				Brt. forward	129	2	21
No. 1.	4	0	14	No. 36.	3	3	14
2.	4	3	26	37.	4	2	24
3.	3	2	2	38.	4	1	1
4.	3	0	14	39.	4	1	14
5.	3	3	16	40.	3	3	12
6.	3	2	14	41.	4	0	14
7.	3	2	10	42.	3	0	14
8.	3	0	0	43.	4	0	6
9.	3	3	0	44.	3	2	1
10.	3	1	1	45.	4	0	0
11.	3	1	14	46.	4	0	27
12.	3	1	14	47.	4	0	22
13.	3	1	24	48.	3	0	2
14.	3	0	14	49.	3	3	14
15.	3	3	0	50.	4	1	8
16.	2	3	14	51.	4	1	15
17.	4	2	8	52.	4	0	24
18.	4	1	1	53.	3	0	5
19.	3	1	0	54.	3	2	27
20.	3	3	20	55.	4	3	0
21.	4	1	0	56.	3	2	4
22.	3	0	12	57.	4	0	12
23.	4	1	0	58.	4	0	14
24.	3	3	14	59.	4	0	0
25.	4	0	0	60.	4	1	1
26.	3	2	14	61.	4	0	18
27.	3	1	18	62.	4	0	12
28.	3	2	22	63.	4	0	11
29.	4	0	14	64.	4	0	4
30.	3	3	1	65.	3	3	10
31.	4	0	26	66.	3	1	18
32.	3	3	8	67.	3	1	7
33.	4	2	7	68.	3	2	6
34.	2	2	14	69.	4	3	0
35.	3	2	1	70.	4	1	0
	129	2	21		268	3	18

Breaking-Weight of ½-inch Square Cast-Iron Bars 9 inches between Points of Suspension at Zero.

	Cwts.	Qrs.	Lbs.		Cwts.	Qrs.	Lbs.
				Brt. forward	139	1	22
No. 1.	4	1	15	No. 36.	3	2	35
2.	4	0	14	37.	5	0	14
3.	3	0	10	38.	4	0	4
4.	3	0	6	39.	3	3	4
5.	2	3	20	40.	4	1	15
6.	3	3	18	41.	3	0	12
7.	3	1	12	42.	3	1	0
8.	4	2	14	43.	4	2	8
9.	4	0	22	44.	3	3	22
10.	4	1	15	45.	3	2	0
11.	4	0	14	46.	4	2	1
12.	4	2	1	47.	4	1	1
13.	3	1	26	48.	4	0	4
14.	4	0	4	49.	4	0	3
15.	3	2	8	50.	4	2	14
16.	4	3	0	51.	4	0	12
17.	4	1	15	52.	3	0	18
18.	3	2	1	53.	3	2	8
19.	4	1	15	54.	4	0	15
20.	4	2	1	55.	4	1	12
21.	4	2	24	56.	3	1	13
22.	3	2	26	57.	4	1	26
23.	4	1	1	58.	2	3	10
24.	4	1	26	59.	4	1	26
25.	3	3	12	60.	3	2	20
26.	3	0	14	61.	4	0	0
27.	4	1	15	62.	3	2	24
28.	3	0	12	63.	3	3	15
29.	4	2	14	64.	3	0	20
30.	3	2	15	65.	4	0	14
31.	3	0	22	66.	4	0	4
32.	4	3	13	67.	3	0	20
33.	4	1	14	68.	3	2	12
34.	4	0	13	69.	4	2	1
35.	3	2	18	70.	4	0	1
	139	1	22		276	3	0

	Cwts.	Qrs.	Lbs.
At 70° F.	268	3	18
At zero.	276	3	0

Mr. THOMAS CARRICK called attention to the fact that the tabulated statement of Mr. Spence's experiments showed a maximum breaking weight of about 5 cwts. and a minimum of about 3 cwts. The minimum breaking-weight was therefore 40 per cent less than the maximum. With experiments showing such an excessive range in the breaking-weight of bars, which from the care taken in their production ought presumably to have been homogeneous in quality, it was very unsafe to rely upon a resulting difference of only 3 per cent derived from separately adding the breaking-weights of each set together and comparing the gross results. The iron used was obviously of an inferior quality and quite unsuitable for the purpose of reliable experiments.

ON THE PRIORITY OF THE DISCOVERY OF ANILINE COLOURS.

HAVING been favoured by Dr. A. Bauer with a copy of a lengthy paper on the above subject, which was published in the *Neue Freie Press* of Vienna of the 3rd of January last, we abstract from that paper the following. It has been written in reply to an article which appeared in the same newspaper on the 6th of December last, wherein it was said that the late Dr. Jasznüger, formerly Professor of Chemistry at the Imperial-Royal (Austro-Hungarian) Theresia University, was the

first and real discoverer of all those colours which modern chemistry has produced from aniline, naphthaline, anthracen, and phenol, while these discoveries were stated to have been made as early as the year 1816; and, as the reason why Dr. Jasznüger had never divulged his knowledge, nor published the secrets of his preparations, it was said that he had been compelled to do so by the machinations of his rivals and enemies, Drs. Prechtl and Jaquin of the same University.

Dr. Bauer reviews and scrutinises at length the documents purporting to prove the correctness of the above statement, as published in the newspaper above named in December last. As a *resumé* of the entire controversy, we may here state that Dr. Bauer conclusively and clearly proves that the colours obtained by Dr. Jasznügel from coal and peat (the latter being, as is well known, a material altogether unfit to obtain the so-called aniline colours), are nothing like the coal-tar colours, but are—(1) A peculiar black, which, according to independent testimony, appears to have been akin to lampblack. (2) Dr. Jasznügel stated himself that he had been successful in obtaining, from coals (not coal-tar) and peat, such dye materials as would render the use of certain astringent substances, and other exotic materials then (1814—1817) used in dyeing, unnecessary, in consequence of the possibility of obtaining these substances artificially. It is further clearly and impartially proved by Dr. Bauer that it was almost impossible to expect that, considering the comparatively very crude state of chemistry nearly sixty years ago, either Dr. Jasznügel, or anybody else, should at that time have discovered coal-tar colours; for even if, by mere accident, he had come across a reaction while operating on coal-tar, which reaction exhibited a peculiar colouration, the *rationale* thereof and further investigation thereon would have been out of the question. Dr. Bauer's object, in writing a lengthy paper on this topic, was to prove the groundlessness of Jasznügel's claim (never, however, made by himself), but lately brought forward for the purpose of showing that, through the animosity of Drs. Prechtl and Jaquin (who, by the bye, are fully exonerated and exculpated from any such malignity), Austria had lost the honour of being the country wherein the discovery of aniline colours was really made.

IMPROVED PROCESS OF EXTRACTING SILVER AND GOLD FROM ARSENIO-SULPHURETS OF LEAD, COPPER, &c.

By C. WIDEMANN.

THIS very interesting and entirely new process was discovered and has been patented in all mining countries by Cyprien Marie Tessié du Motay, of Paris, France, and is already practised on a large scale at the metallurgic establishment of Coumnies, France. The process consists in the following series of docimastic treatments of the simple sulphurets, the complex sulphurets, and the arsenious sulphurets of lead, antimony, copper, and iron, as well as coppery matts and coppers containing precious metals, in order to extract silver and gold therefrom at a great saving in time and labour.

First. In roasting the simple or complex sulphurets, the antimonial sulphurets, and the arsenio-sulphurets containing silver or gold, in the presence of pure silicates, of auriferous quartz or earthy and metallic silicates, adding, in order to complete this roasting and to expel all the sulphur contained in the minerals, either lead, which is intended to form oxide of lead, or litharge, or any other metallic oxide capable of producing, in contact with air or oxidising flames, peroxides or silicates of peroxides.

Second. In thus transforming into the state of very fusible basic silicates, the oxides of the desulphuretted metals.

Third. In melting or running in the melted state the silicates of this kind produced upon a matt of lead also melted, and in stirring or agitating them, either by paddles held in the hand or by mechanical means, or by means of gases mechanically employed, up to the moment when the gold and silver are entirely dissolved in the melted lead.

Fourth. In separating the poor scoria deprived of the precious metals of the lead, which has taken them up, and in stiring or agitating upon the same mass of lead a fresh quantity of rich scoria.

Fifth. In repeating this liquation an indefinite number of times, until the moment when the capacity of saturation of the lead for the precious metals, which is lessened by each operation, no longer permits the continuance of this mode of treatment.

Sixth. In testing the lead saturated with silver or gold, by the methods of cupellation now in use, in order to extract therefrom the precious metals.

Seventh. In removing the poor scoria, the oxides of lead, antimony, and copper, which, for the most part, are contained therein, by bringing back these oxides to the metallic state by the separate or united action of charcoal and iron.

Eighth. In separating, by the special methods presently described, the copper and antimony from the lead with which they are united.

Ninth. In re-employing, either wholly or partly, the purified lead in the treatment, by oxidation and silication, of fresh quantities of minerals.

Tenth. In reducing, either in reverberatory or cupola furnaces, or in all other melting furnaces, the basic silicates enumerated above by the action of charcoal or iron, when the latter are the produce of minerals containing copper pyrites in considerable quantities.

The metallic matter thus obtained consists of an alloy of copper, lead, silver, and gold, free from sulphur, which may be all treated at once, either by docimastic methods in countries rich in combustibles, or by the humid process in countries where mineral acids are low in price. Having thus stated, in a general manner, M. du Motay's docimastic method, let us describe the new operations and reactions whereby they are essentially distinguished from those at present employed for the same object. These operations and reactions consist, in the first place, of the roasting, the oxidation, and the scorification of the simple or complex sulphurets of antimonio-sulphurets and arsenio-sulphurets in the presence of silica and oxides of lead, or of all other metallic oxides capable of passing into the state of peroxides or of silicate of peroxides in the oxidising flames, in order—

1. To prevent the formation of the oxysulphurets of lead, antimony, and copper, which afterward, in dissolving with the silver or gold in the lead, cause the loss, during the cupellation of an appreciable quantity of the precious metals, which are dissolved in this lead, and render inapplicable for industrial purposes either the cupellated litharges or the lead proceeding by reduction from the said litharges.

2. To prevent the complete dissolution in the lead of the silver and gold contained in the basic silicates free from sulphur, without the antimony or copper, which have passed from the state of sulphurets into the state of silicates, being able to dissolve in the lead, and consequently to injure it.

3. To obtain as the final result of a series of liquations, a testable (cupellable) lead, rich in precious metals.

4. To avoid a great number of cupellations to obtain pure litharges transformable into lead of an equal purity, and to thus diminish the net cost of the industrial extraction of silver and gold, by means of the cupola, to a considerable extent.

The operations and reactions, in the second place, consist in the reduction to pure lead, or into an alloy of lead and antimony, and copper of the scoria deprived of gold or silver, in order—

1. If the extracted lead is pure, to make it again serve by way of roasting, for the oxidation of a fresh supply of sulphuretted, arsenio-sulphuretted, or antimonio-sulphuretted minerals.

2. If the lead is alloyed with antimony or copper, or with both these metals, to separate it from one of these metals or both together, in order also to use it again, after purification, for the oxidation of a fresh quantity of sulphuretted, arsenio-sulphuretted, or antimonio-sulphuretted materials.

The method for separating the lead from the antimony, or from the antimony and copper united, constitutes one of the greatest novelties and one of the most essential parts of the invention; taking, for example, an alloy of the lead and antimony, the inventor submits it, after having melted it in a reverberatory or a cupola furnace, to the action of the nascent steam produced by aërohydric or oxyhydric blowpipes, fed by a mixture in definite proportions of air, or of oxygen and pure hydrogen, or carbonated hydrogen. The flame procured by these blowpipes should be as free as possible from any trace of uncombined oxygen. It is even preferred, in order to prevent any oxidation of the lead, that the flame should contain a little hydrogen or free carbon. The nascent steam may, perhaps, be mixed with the ordinary steam generated at 212° Fahrenheit. The antimony, which decomposes water at a high temperature, oxidises in passing into the state of antimoniate of oxide of antimony, one portion of which volatilizes while the other remains attached to the inner sides of the reverberatory or other furnace, in this operation, during which almost the whole of the antimony is separated, and the lead, which does not decompose water, is but little, or not at all oxidised, but still retains traces of antimony with a strong affinitive force, and in order to entirely purge it from this metal, it is necessary to have recourse to sulphate of lead. This new reactive has the property of becoming decomposed in oxide of lead, into free oxygen, and into sulphurous acid by antimony, which, by this decomposition, taking up the oxygen set at liberty, oxidises and combines with the oxide of lead of the decomposed sulphate. The lead is then completely purified and rendered applicable for all industrial purposes. It follows, as a matter of course, that the sulphate of lead can, by itself, without the previous employment of steam in the nascent state, separate the whole of the antimony contained in an alloy of this metal with the lead, but, in many cases, to employ it would cost too much. Earthy hydrates, such as hydrates of lime and baryta, can also be effectually employed instead of steam in a nascent state, or ordinary steam from water, in order to oxidise the antimony and to separate it from the lead; but the inventor prefers the steam generated by aërohydric or oxyhydric blowpipes, which furnish at the same time the heat necessary for the fusion of the alloys and the reactive, which partly or wholly removes from the lead the antimony which injures it. When the lead is alloyed with copper, and this alloy does not contain antimony, it is melted with a quantity of sulphuret of lead rather more than equivalent to the quantity of copper, to transform into sulphuret; this fusion is conducted away from any oxidising action in a reducing medium, and produces an immediate reaction by way of double exchange. The sulphur combined with the lead acts upon the copper of the alloy, aud thus substitutes metallic lead for the copper, which scorifies and passes into the state of sulphuret. The lead thus deprived of copper, is pure and proper to be employed, as indicated above, either for the oxidation of fresh mineral, or it may be sold for general purposes. Alkaline and alkaline earths, bisulphurets, and polysulphurets, as well as metallic sesquisulphurets and bisulphurets, may be substituted for the sulphuret of lead, in order to remove the copper from the lead by causing the latter metal to pass into the state of sulphuret. The sulphuret of copper may, after roasting, be transformed into metallic copper by the reducing process at present employed. When antimonio-sulphuretted argentiferous leads have been previously brought to the metallic state by the method of reduction at present employed, the inventor submits them to the action of the same blowpipes, and when the antimony, which has passed into the state of oxide, has been separated from the lead, in which the silver remains entirely dissolved, this lead is tested or cupellated, and the precious metal extracted therefrom. The chief points of novelty in this invention may be stated as follows:—

1. The method of roasting and the silicatisation of the metallic, simple, or complex sulphurets, arsenio-sulphurets, and antimonio-sulphurets containing silver or gold, by means of the processes above described.

2. The method of liquation and fusion by successive series of argentiferous and auriferous silicates upon the same bath of lead, which deargentises and deaurifies them, by which method the same object is obtained by one cupellation which according to the best methods at present in use requires several.

3. The method by which, after the oxides of lead, antimony, or copper contained in the silicates deprived of silver and gold have been brought back to the metallic state, the lead is separated from the copper with which it is united by the addition of an equivalent quantity of sulphuret of lead, or of one of the sulphurets enumerated above, and the antimony, by the action of the aërohydric or oxyhydric blowpipes, combined with the reaction produced by a small amount of sulphuret of lead.

4. The application of the above-described methods to the entire or partial treatment of copper matts and argentiferous and auriferous coppers of the minerals of antimoniferous lead, and of the mineral of antimony containing silver and lead or pure silver.

We have no doubt this process will be accepted all over the world, as the series of manipulations are thus greatly simplified, as already oxygen is manufactured on a large scale at a reduced price, and so will be pure hydrogen in a very short time; these two gases used in a blowpipe will satisfy in a practical way all the exigencies of the gold and silver refiners and smelters.—*Journal of Applied Chemistry*.

FURTHER EXPERIMENTS ON THE EFFECT OF DIET AND EXERCISE ON THE ELIMINATION OF NITROGEN.*

By E. A. PARKES, M.D., F.R.S.

THIS lengthy and very interesting paper contains the account of a series of physiological experiments very carefully instituted by the author, assisted, first by Count Wollowicz, and afterwards by Serjeant Turner, of the Army Hospital Corps. The subject of the experiments was a perfectly healthy soldier 25 years of age, who weighed 145 lbs., and was a very powerful man, having been an ironworker (puddler) before enlistment; the series of experiments made are: first, ordinary regulated diet, including the careful determination of the amount of excretions, and the determination of the nitrogen therein contained, also the mean pulse and mean temperature of axilla and rectum. The second series of experiments with prepared concentrated food was discontinued in a short time, owing to the food causing indigestion. The third series of experiments with non-nitrogenous food was conducted in all particulars as the first series. As general results the author points out that, with regard to the temperature, it may be concluded that a non-nitrogenous diet continued for five days neither raised nor lowered the temperature of the axilla and rectum; it also appears that when the nitrogenous food of a healthy man was reduced to one-half for five days, and he was then kept for five days without nitrogen,

* Abstract of a paper read before the Royal Society.

he was able, on the fourth day after such deprivation, to do a very hard day's work. The non-nitrogenous food, consisting of butter, oil, starch, and sugar, kept him perfectly well, all the functions seemed natural, the man felt in all respects healthy, but on account, however, of the feebleness of the heart's action, it was not thought proper to continue the experiments, which, according to Dr. Parkes's opinion, had sufficiently proved that force necessary for greater muscular work can be obtained by the muscles from fat and starch, though changes in the nitrogenous constituents of the muscles also go on which have as one effect an increased, though not excessive, elimination of nitrogen after the cessation of the work.

ON THE CONGELATION OF BISULPHIDE OF CARBON.

By N. V. WARTHA.

THE congelation of bisulphide of carbon, which, according to the treatises on chemistry, requires a temperature of −90° for its solidification, may be easily effected by directing a very rapid current of dry air upon the surface of the pure liquid (purified by an amalgam of silver) contained in a glass vessel.

If a thermometer be plunged into the bisulphide of carbon during this operation, a snowy crust will be noticed covering the sides of the vessel and the thermometer, even before the temperature has become 0°. The temperature then rapidly decends to −18° and a white mammillated mass rises to the surface, and sometimes even stops up the tube for conducting the air. Soon all the liquid disappears and the thermometer commences to rise again up to −12°, where it remains stationary as long as the bisulphide of carbon is solid. In this state it presents the same phenomena as solid carbonic acid.

The bisulphide of carbon will remain solid for some time, and in this state it possesses a peculiar aromatic odour. Its formation may be utilised for the production of ice, thus: add to some water contained in a capsule, a few cubic centimetres of bisulphide of carbon, and bring a rapid current of air to play upon it. The water will soon solidify, just as the bisulphide of carbon itself, provided the latter is present in sufficient quantity; the temperature of the mixture may then reach −15°.

Bisulphide of carbon cannot be solidified *in vacuo*, except it be mixed with ether.

The temperature above cited are in degrees centigrade.
—*Deutsche Chemische Gesellschaft*, 1870, No. 2.

NOTICES OF BOOKS.

Lessons in Elementary Physics. By BALFOUR STEWART, LL.D., F.R.S. Macmillan and Co.

MANUALS in which theory is so far illustrated by practical application as to convey clear ideas to the student are very rare, and the advent of such a work during one's studentship is to be fully appreciated by those only who have little assistance other than that afforded by their text-books. Clearness of definition, too, is not often the characteristic of an elementary work, and when, as in physical science, definitions are so various and terms so arbitrarily used, any guide that puts before the student a comprehensive and yet sufficiently full exposition of his subject, is to be commended in the highest degree. It may be expected that from the pen of Dr. Balfour Stewart there should emanate such a work, yet it is not always the case that men who are proficients in any subject are also calculated to impart the best elementary instruction in that subject. When a fact is known, the possessor almost naturally comes to the conclusion that it must be equally well known to others. This predisposition to accredit others with the knowledge they do not possess perhaps accounts for the occurrence that so many works written by able men are useless to the mind endeavouring to grasp first principles. Indeed, many so-called elementary books serve better as *aide memoires* to the man who has "passed" than as guides to the student preparing for matriculation. All who have with great labour sifted the seed from the many manuals heretofore afloat. will envy those now commencing their studies to whom is known the admirable little text-book entitled "Lessons in Elementary Physics."

Explaining, as it does, in a few hundred octavo pages, the most important of those laws which regulate the phenomena of nature, its descriptions are quite full enough to obviate in many cases reference to more extensive authorities, while the explanations of the various delicate philosophical instruments and their principles might, with advantage, be emulated by more pretentious works.

The difference between actual or kinetic and potential energy is here laid down with a distinctness that must carry understanding with it. After classifying the various forms of energy, Dr. Stewart goes on to consider the laws according to which they are transmitted into one another, giving in a concise chapter the principles of conservation of energy. The illustrative experiments in sound, heat, light, electricity, and magnetism, through all of which the various forms of energy are traced, are really of practical worth, especially the explanation of the polarisation of light. Considering a ray of sunlight as consisting of an impartial mixture of horizontal and vertical vibrations or waves, all taking place at right angles to the direction of propagation, the author goes on to explain "that there are certain substances which admit of the progress through them of a ray of light of which the vibrations all take place in one plane, while, however, they stop nearly all rays consisting of vibrations in a plane at right angles to the first," giving in illustration a string vibrating freely with a vertical undulation between two parallel vertical plates, but being prevented vibrating vertically beween two horizontal plates. Finally, in his concluding remarks, Dr. Stewart shows that with the exception of tidal energy, all the work done in the world is due to the sun, and stating that, though it is larger and hotter than any fire, yet there is no apparent reason why it should form an exception to the fate of all fires—to die out—its only difference being one of size and time. Without doubt this latest production of Dr. Stewart will become the text-book of the day.

Dr. Dobell's Reports on the Progress of Practical and Scientific Medicine in Different Parts of the World. Contributed by numerous and distinguished coadjutors. Vol. II., for the year 1870 (from June, 1869 to June, 1870). London: Longmans, Green, and Co., 1871.

IT is with great pleasure that we have perused this second volume of a valuable work, for which the thanks of the medical faculty are due to its eminent compiler and editor, Dr. Dobell.

The volume opens with a report from France, from the hand of Professor Villemin, and we agree with Dr. Dobell that special thanks are due to Professor Villemin for having punctually performed his task, notwithstanding that he was at the head of a hospital full of wounded and surrounded by every kind of distraction. As an instance of the great variety of subject matter, we quote a few particulars from Dr. Saxby's report on "The Shetland Isles" (northern group, the Dr's. residence being at Baltasound). The climate, though damp, is far less severe than is generally supposed, and would be inferred from the situation in so high northern a latitude; the mean annual temperature being 2·63° above Orkney, and only 1·08° below Glasgow. The prevailing wind throughout the year is S.W. The greatest cause of disease appears (as far as in-

fluenced climatologically) to be the sudden changes of temperature, sometimes falling in summer from 81° F. (in the shade) to 48° F. within two days time. As a curiosity in reference to the mode of living of the inhabitants, we notice from this excellent and interesting report that they indulge in tea drinking to such an excess as to make it as ruinous to them as dram drinking elsewhere.

It would be simply impossible to quote even a hundredth part of the interesting scientific facts– leaving even purely medical, physiological, ethnological, and other matters thereunto pertaining out of the question—with which this book abounds. It deserves a place not simply in the library of medical men and practitioners, but in that of all who take an interest in scientific matters generally.

A Manual of Chemical Analysis, Qualitative and Quantitative. For the use of Students. Part I. Qualitative, with special directions for the detection of poisons. By HENRY N. NOAD, Ph.D., F.R.S., &c. Fourth edition. New Notation. London: L. Reeve, and Co.

THIS is the fourth time it has been our pleasant duty to speak upon this excellent work. All who know anything of qualitative analysis must be aware that it is by no means an easy task to write a book on that subject which will be comprehensible to students. That Dr. Noad has well succeeded in producing such a book is evidenced by the fact that it has now reached a fourth edition.

We can now, as we did before, recommend this manual with confidence to all who may be in want of a book on this subject. This edition has been, in every respect, brought up to the present advanced state of the science.

Gout and Rheumatic Gout: A New Method of Cure. By JOHN W. FOAKES, M.D. London: George Philip and Sons.

THE author has for many years adopted a somewhat exceptional, although a chemically sound, treatment for cases of gout and rheumatic gout, which he describes in the work before us. His object is to prevent the frequency and severity of the attacks without using such depressing and injurious medicines as mercury and colchicum, and without weakening or undermining the patient's constitution. The views of the author on the action of mercury seem to accord with those of Dr. Bennett as expressed in the *British Medical Journal*, and a careful examination of the true action of such drugs on the system shows clearly that, while they may give temporary relief, their after effects are most baneful. The views of such men as Dr. Foakes and Dr. Bennett are, we are glad to say, beginning to gain ground amongst the medical profession, and as our contemporary, the *Medical Times and Gazette*, remarks, in speaking of the report of the Edinburgh committee of the British Medical Association, on the cholagogue action of mercury — There is one advantage resulting from the scientific work of the present day; in upsetting old theories it paves the way for new ones: it does this, too, by more accurately recording facts, and so making the new views more nearly approximate to truth. Our knowledge on the subject justifies us in recommending Dr. Foakes's little work to the attention of those interested in the subject.

CORRESPONDENCE.

"THE OVERTHROW OF THE SCIENCE OF ELECTRO-DYNAMICS."

To the Editor of the Chemical News.

SIR,—Under the above title, the Manchester Literary and Philosophical Society has just published a paper by Dr. John Hopkinson, the Senior Wrangler, I presume, of the present year.

In this paper, the distinguished author criticises severely some papers of mine published in the CHEMICAL NEWS and the *Quarterly Journal of Science*.

Dr. Hopkinson quotes one of my articles as follows:—"They (that is Joule and Scoresby) calculate the maximum theoretical power of a grain of zinc to be 158 ft.-lbs., and yet, using permanent magnets, which, by their own statement, were so badly constructed as to have only a quarter the power they ought to have had, with the poles of the electro-magnets never approaching the permanent magnets nearer than a quarter of an inch (and what an enormous loss is incurred here!); with an engine constructed almost at hap-hazard, and with scarcely a consideration of the best principles or of the most advantageous construction of such engines, they actually obtained a result of 102·9 ft.-lbs. out of a calculated theoretical maximum of 158. With a little care and consideration, I do not hesitate to say the duty per grain of zinc might easily have been increased tenfold." On which he observes—"It is hardly credible, but the above looks very like a confusion between Force and Work! The author seems to assume that, if the forces in operation in an engine are greater, that the engine will necessarily produce more work from the same quantity of fuel. In these experiments, the quantity of zinc $(a-b)$ used to produce work, W, is observed. If the engine was made more powerful, if the permanent magnets were four times as strong, and the electro-magnets passed ¼th of an inch from them, doubtless W would be greater; but so, also, would $(a-b)$, and it does not follow that $\frac{W}{a-b}$, with which we are concerned, would be at all changed. What becomes, then, of the dogmatic assertion that the duty of a grain of zinc would be increased tenfold?" Why he should say "It is hardly credible, but the above looks very like a confusion between Force and Work," I know not. I cannot plead guilty to having made the slightest confusion between the two. But Dr. Hopkinson tries to persuade us that a well-constructed engine would do no more duty than an ill-constructed one; and consequently I presume that the magnets might possibly be weakened *ad infinitum*, and removed to ever so great a distance, without necessarily affecting the efficiency of the engine! And then he criticises my papers as full of fallacies! I reply that the above looks very like a confusion between $(a-b)$ and b! In these experiments of Joule and Scoresby, the quantity of zinc used to produce work, W, is represented by the authors, not as $(a-b)$, but as b, and therefore the duty per grain of zinc is not $\frac{W}{(a-b)}$, but $\frac{W}{b}$; and when the permanent magnets are stronger, and the electro-magnets are passed nearer to them, not only does W increase, but b also diminishes. So that, was I not justified in saying that the duty of a grain of zinc could, in a better constructed engine, be probably increased tenfold? And if it be increased only twofold, I have proved my point, and disproved Joule's mechanical equivalent of heat.

Next let us take Dr. Hopkinson's next criticism. My argument is this—that if the doctrine of the mechanical equivalence of heat be, *that production of energy absorbs, and destruction of energy produces, a definite amount of heat*, and if we find cases, as those of elastic wires, and water below its maximum density, in which destruction of energy produces cold not heat, the doctrine of the mechanical equivalence of heat cannot be universally true. To this argument Dr. Hopkinson replies that what I quote as paradoxes are simple deductions from the two laws of Thermodynamics. Quite true, but this only shows that one of the two laws of Thermodynamics is inconsistent with the doctrine of the mechanical equivalence of heat.

If I said anything which *seemed* to imply that a minimum of work in an engine was inconsistent with a maxi-

mum of duty, I freely retract the expression; and I also acknowledge that the argument drawn from the fire syringe had better have been omitted. But my point was proved abundantly without it. I have now answered all the points of Dr. Hopkinson's criticism, and I confidently leave the decision on them to anyone who can endure to see a false idol of science broken.—I am, &c.,

H. HIGHTON.

Putney, March 9, 1871.

PS. I hope to discuss the whole question *vivâ voce* at the meeting of the Manchester Literary and Philosophical Society next week.—H. H.

MISCELLANEOUS.

Balloon Letters.—Messrs. Letts, Son, and Co., have just published an interesting balloon letter from Paris as a memento of the late war and the advance of balloon navigation.

London Institution.—The third *conversazione* of the season was held on Wednesday evening at the Society's house in Finsbury Circus. Mr. Henry Holiday delivered an interesting lecture on "Stained Glass," which, with instrumental music and the exhibition of microscopic objects, works of arts, &c., rendered the evening agreeable to the numerous visitors.

Magnetic Motive Power.—We desire to re-affirm the fact to which we, in our last issue, with some superfluous enthusiasm, perhaps, referred, and of which, since then, we have received new corroboration. We have first the data of an examination by an experienced engineer, who gives the result of his examination as follows:—

Number of cells of battery	4
Number of revolutions per minute	340
Diameter of pulley	12 in.
Pressure of brake	65 lbs.
Developed in horse-power.	1·99 to 2.

We do not now accept the theory of infinite development, for we know nothing about it. We do not accept the postulate that there is absence of a positive relation between the consumption of battery and the magnetic development, for that stultifies our judgment. But we do contend that the production of a large magnetic force is desirable from inexpensive elements, whose power we have never suspected, and which, to us, is prophetic of great results.—*New York Telegraph Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Moniteur Scientifique, No. 331, October 1, 1870.

We have received the back numbers of this periodical, almost the only scientific paper which has been regularly printed during the late war and siege of Paris. We sincerely hope such a cause of stoppage of communication with Paris will never occur again. This number contains the following original matter relating to chemistry and allied sciences:—

Vinage.—The continuation of the paper quoted, with names of authors, in CHEMICAL NEWS, vol. xxii., p. 60.

No. 332, October 15, 1870.

This number contains the following original matter relating to chemistry and collateral sciences:—

Supply of Food to Inhabitants of a Besieged City.—G. Grimaud de Caux.—A lengthy paper, chiefly the summary of a memoir read by the author at the meeting of the Institute on the 26th of September last, and the discussion which followed.

White Gunpowder.—A. Roseleur.—It appears, from this short paper, that the well-known mixture, consisting of 2 parts of powdered chlorate of potassa, and 1 part each of ferrocyanide of potassium and sugar, has been made on the large scale at Paris; but, from some unknown and entirely unaccountable cause, an explosion has taken place, whereby the works were destroyed and thirteen workmen instantly killed.

The Food Question.—Dr. Sée.—An extract from a free and public lecture delivered at the Medical School for the purpose of imparting some sound knowledge on the quantity of food required to keep man in a vigorous and healthy state. The daily ration for an adult might be enumerated as follows:—100 grms. of meat, 20 grms. of salt fish, 750 grms. of bread, 50 grms. of lard, and 50 grms. of dried and compressed vegetables—a total of 970 grms. of solid food, containing 88 grms. of albuminous matter. Incidentally, the author observes that crust of bread contains just twice more nutrimental value than crumb, which contains 44 per cent of water. The highly nutritive value of wine is specially alluded to, and illustrated by the fact that, in some districts of France and Spain, men live on bread and wine only for many weeks together in a healthy and vigorous state.

No. 333, November 1, 1870.

This number opens with a lengthy abstract of the subject-matter discussed at the meeting of the Institute on the 10th of October last, the main point under notice being—

The Preservation of Meat, and the Best Means of Utilising, Economically, the Various Parts, inclusive of Bones and Blood, obtainable from Cattle, Sheep, and Pigs.—J. Dumas.

Action of Disinfectants, and especially on Phenic Acid.—A. Devergie.—This lengthy essay does not contain anything new on this subject.

Principal Preparations of Phenic Acid sold in Paris.—Dr. Quesneville.—The author enumerates no less than ten different preparations, including the pure solid acid, and solutions thereof, at varying strength, in water, alcohol, acetic acid, glycerine, vinegar; also lozenges and phenic-aromatic vinegar.

No. 334, November 15, 1870.

This number contains the following original matter relating to chemistry and allied sciences:—

Pneumatic Telegraphy.—M. Guattari.—This paper contains an account of a suggestion, rather than an invention, relating to the application of strongly-compressed air (to eight or nine atmospheres, from 120 to 130 lbs. per square inch), to be conveyed in narrow tubes at certain distances, and to set in motion, at stations, pistons placed in cylinders.

Discovery of Hyposulphite of Soda, and Observations on the Nature of this Salt.—MM. Chaussier and Vauquelin.—The reproduction of a paper (now well nigh forgotten) originally published in the *Journal de la Societé des Pharmaciens de Paris*, No. 6, 25 Brumaire, an. viii. (November 15, 1800). The contents of this paper are curious, as instancing the state of chemical knowledge at that period, but Vauquelin's experiments and analysis of the salt alluded to, and then made, have never been controverted.

Colouring Matter Suitable for Imparting a Good Colour to Butter.—Dr. Quesneville.—The author took carrots, cut them into slices, and dried them; and after that, ground them to powder and exhausted the powder with sulphide of carbon. That solvent having been removed, an extract was obtained, which rapidly crystallised, yielding pure carotine, an insipid, inodorous substance, akin, as regards its physical appearance, to alizarine. This material was employed for some time for colouring butter, giving great satisfaction, as being in every respect superior to annatto, but rather more expensive.

Nos. 335 and 336 (double number), December 1 and 15, 1871.

This number contains the following original matter relating to chemistry and collateral sciences:—

Best Compositions for Chemical Manures, and on the Analysis of Soils, as Propounded by M. George Ville.—Dr. Grüneberg.—This lengthy essay contains the main leading points of a lecture given on the above-named subject before a farmer's club at Cologne. As an abstract of all that has been done and published by M. Ville *in extenso*, this paper is of value.

Air Balloons which can be Steered in any Desired Direction.—Rev. F. Moigno.—A lengthy account of all that has been really and effectively done as regards this subject.

Source of Obtaining Chloride of Sodium which has not been thought of at Metz, and on the Action of Salt on the Human Body.—Dr. Quesneville.—The author calls attention to the fact that urine contains from 3 to 8 grms. of salt in 1000 grms., but does not specify how this salt could be extracted so as to be readily available again for use as a necessary condiment, since it would not be an easy matter to separate the chloride of sodium from the sulphates of soda and potassa, and the phosphate of soda simultaneously present in the

saline mass obtained after evaporation and ignition of the salts contained in urine.

Resignation of M. J. Dumas as President of the Mint Committee.—It appears, from an extract of the official paper of the French National Government, here reproduced (dated November 18th last), that the *savant* just named tendered his resignation, although invited to retain his post, after the dismissal of his son, M. E. Dumas, from the position of assayer to the *Bureau de Garantie des Objets d'Or et d'Argent*—that is to say, the head of that branch of administration connected with the Mint which performs the duties which in this country, by several ancient Acts of Parliament, devolve upon the Goldsmiths' Company, viz., the assaying and stamping of gold and silver ornaments and plate for domestic use.

Nos. 337 and 338 (double number), January 1 and 15, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and collateral sciences:—

Historical Resumé of all that has been Experimentally done and published in reference to Gelatine.—Professor Chevreul.—This excellent memoir, too lengthy and too concisely written for any useful abstraction, contains all that is really valuable and practically available on this subject.

Peculiar System of Telegraphic Correspondence—A. Guiot—And on—

Pigeon Post—Rev. F. Moigno—Are both papers specially bearing upon well-known events.

Force Exerted by Gunpowder and other Explosive Substances.—Dr. Berthelot.—This very valuable memoir contains the following sections:—General relations and definitions; heat of composition of the oxygen compounds of nitrogen; gunpowder containing saltpetre; gunpowders containing nitrate of soda; chlorate of potassa gunpowder; chloride of nitrogen; nitroglycerine; gun-cotton; picrate of potassa, either pure or mixed with other substances.

Nitroglycerine and Various Dynamites.—C. Girard, A. Millot, and G. Vogt.

Effect of Intense Cold on the Human System.—Dr. Quesneville.—A physiological essay.

Nos. 339 and 340 (double number), February 1 and 15, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and collateral sciences:—

Composition of Milk, and on the Preparation of Obsidional Milk (Lait Obsidional).—M. Dubrunfaut.—This paper, and the two following, bear upon the late exceptional condition and poverty of milk in Paris.

Preparation of Artificial Milk.—A. Gaudin.

Report to the Academy of Medicine on Substitutes for Milk.—Dr. Gubler.

Force Exerted by Explosive Gas Mixtures.—Dr. Berthelot.—Reserved for reproduction and translation.

Dynamite, and its Use as a Substitute for Gunpowder.—P. Champion.

Preservation of Meat.—Dr. Baudet.—This memoir contains the detailed account of a series of experiments made by the author on this subject. The paper is of very great importance generally.

Geology of Meteorites.—S. Meunier.—An extensive monograph on this subject.

Crystals of Albumen.—Dr. H. Lissagaray.—A preliminary notice on this subject, the author having been obliged to leave his laboratory for the purpose of becoming a soldier of the 83rd battalion of mobiles.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 1, 1871.

This number contains the following original papers and essays:—

Combustion Furnace for Organic Elementary Analysis.—A. Müller.—This paper, illustrated by a woodcut, required for the proper understanding of the subject, opens with the following remarks bearing upon the conditions and requirements of a good combustion-furnace for organic elementary analysis. It ought to give a heat sufficient to bring to incipient fusion difficultly fusible hard potassa glass. The tube should be uniformly heated over its entire length, and also to the same degree top and bottom. The operator should be able to control the degree of heat within all required limits, and, lastly, the combustion should be from first to last so conducted as to be, in all respects, under the observation of the operator.

Sulphanilic Acid.—E. Ador and V. Meyer.—This lengthy memoir treats chiefly on the substitution products obtainable from the acid alluded to, and on the constitutional formulæ of these bodies.

Lecture Experiment for Illustrating the Phenomena of Diffusion.—Dr. F. Wöhler.—With a woodcut.

Basicity of Oxide of Uranium, Molybdic Acid, Boric and Nitrous Acids.—C. Schultz-Sellack.—This paper contains the following sections:—Sulphate of antimony, $Sb_2(SO_4)_3$; percentically—Sb_2, 45·45; $(SO_4)_3$, 54·55. This salt is not affected by dry air, but decomposed by water, and by ignition sulphuric anhydride is given off. Sulphate of bismuth, $Bi_2(SO_4)_3$. Normal sulphate of uranium, $(UO)_2SO_4$.—This salt crystallises from its solution in concentrated sulphuric acid; the substance is amber-coloured, soluble in water, and deliquescent. Acid sulphate of uranium, HUO,SO_4. Anhydrous acid sulphate of uranium, $(UO)_2SO_4+SO_3$. Sulphate of molybdenum, $(MoO)_2SO_4$. Sulphate of boric acid, or sulphuric boric acid, $2(HBOSO_4)+SO_3$.—In 100 parts—2BO, 16·46; H_2, 0·61; $3SO_3$, 73·71. Best obtained by dissolving boric acid anhydride in fuming sulphuric acid, when crystals are formed after a while, being the compound in question.

Formation of Pyrocatechin from Carbo-Hydrates, and more especially Cellulose.—F. Hoppe-Seyler.—This paper treats on the products formed by the combustion (dry distillation) of paper and other carbohydrates at temperatures not exceeding 210°, and with or without the presence of water. The experiments on this subject, and especially the mode of formation of pyrocatechin, are not yet completed.

Tin-Triethyl-Phenyl.—A. Ladenburg.—The body just named, $Sn(C_2H_5)_3C_6H_5$, is a colourless fluid, boiling at 254° without decomposition. The vapour of this body is partly decomposed by the action of the air. The fluid is readily soluble in ether and absolute alcohol, but insoluble in water; sp. gr. at 0°, 1·2639; burns with a luminous, sooty flame, leaving metallic tin; added to alcoholic nitrate of silver solution, the result is the reduction of the silver.

Some Reactions of Stanno-Triethyl.—A. Ladenburg.—This paper is the concluding portion to an essay on the subject, commenced in another portion of this periodical.

Action of Cyanide of Potassium on Bromonitrobenzol.—V. von Richter.—This paper treats, at great length, on the action which pure cyanide of potassium exerts when heated in sealed tubes at from 180° to 200° along with bromonitrobenzol. Carbonate of ammonia and ammonia gas are formed; while the contents of the tube, after boiling with caustic potassa and precipitation with sulphuric acid, yielded two new acids, which appeared to contain bromine, but not a nitro-compound. The acids were not obtained in pure state, and the author continues his researches on this subject.

The Law of Avogadro.—A. Naumann.

Hypothesis of Avogadro.—L. Meyer.

New Derivatives from Resorcine.—P. Weselsky.—After briefly referring to a series of experiments formerly made by him, the author gives a short and preliminary account of the action of nitrous acid upon resorcine, resulting in the formation of a compound containing three molecules of resorcine and one molecule of N_2O_3. The body thus formed is reddish coloured, crystalline, yielding, when dissolved in alcohol, a purplish-red coloured solution, which, by the addition of alkalies, becomes deep indigo-blue. The author continues his researches on this subject, which, he states, promises to yield also very important industrial results.

Action of Sulphur upon Benzol.—F. Schulze.—This paper contains an account of a series of experiments made by the author, and consisting in submitting benzol and sulphur (the former being to the latter in the proportion, by weight, of from 64:78), together, to a temperature of some 400°—500°, care being taken to enclose the liquid in small thin-sided sealed glass tubes, and the solid in a combustion-tube, into which (previous to sealing it before the blowpipe) the tube containing the benzole was also placed. The combustion-tube was then put into a stout wrought-iron gas-pipe, well closed with a plug, and the contrivance submitted to strong red heat. The results of this experiment are, that some compound of sulphur and benzol is formed, but the precise definition of the nature thereof is a matter as yet not completed.

New Series of Alcohols.—C. Graebe.—This paper contains, as a preliminary notice, the account of the results of some experiments made by the author with acetyl-benzol (aceto-phenon), $C_6H_5COCH_3$, which substance, when acted upon by chlorine at a higher temperature, yields chlormethyl-benzol, $C_6H_5COCH_2Cl$, a solid body, fusing at 41°, boiling at 246°. Upon being boiled with an alcoholic solution of acetate of potassa, this body yields the acetate of acetyl-benzol-alcohol, $C_6H_5COCH_2(OC_2H_3O)$, a solid substance, fusing at 44°, boiling at 270°; this substance yields, when acted upon by alcoholic solution of caustic potassa, the acetyl-benzol-alcohol, $C_6H_5COCH_2(OH)$.

Blue-Coloured Essential Oil of Chamomile.—J. Kachler.—This lengthy essay contains the detailed account of a series of researches made not only with the essential oil alluded to, but also with the blue oil obtained by the distillation of the galbanum. It appears that the essential oil of chamomile is a very complex substance, consisting of rutinic acid, $C_{10}H_{20}O_2$, of a camphor-like body, boiling between 150° and 165°, $C_{16}H_{10}O$ of a hydrocarbon ($C_{16}H_{16}$). The author's essay also describes at length a series of products obtained by various reagents from the oil.

Metallic Ammonias of the Metallamines.—C. W. Blomstrand.—This exhaustive monograph, full of formulæ, is not suited for any useful abstraction, with due reference to the value of the memoir.

Isomorphism of Soda-Saltpetre, and Calcareous Spar.—L. Meyer.—After observing that the crystalline shape of nitrate of sodium, $NaNO_3$, very closely agrees with the crystalline form of calcareous spar, $CaCO_3$, the author states that, when a rhombohedrically-shaped piece of calcareous spar, cleaned with some dilute nitric acid, is hung by means of a silk thread into a moderately strong solution of nitrate of sodium made with hot water, there is deposited on the crystal of calcareous spar a layer of crystallised nitrate of sodium, just in the same way as when a crystal of chrome alum is hung up in a solution of ordinary alum. The centre of the new crystal first alluded to consists of calcareous spar; while the layer of nitrate of sodium growing round it so deposited, as to make it appear that there was no difference of substance.

Review of the Researches and Investigations made in the Chemical Laboratory of the University of Göttingen.—Dr. B.

Tollens.—This lengthy paper gives a brief catalogically-arranged *resumé* of the subject mentioned; but most, if not all, the subject-matter treated of has been published before this in various periodicals, and noticed therefrom by us.

Report of the Last Meeting of the Chemical Society at Zurich.—O. Meister.—Dr. Tuchschmid read a short note on azoxy-anthracen, a solid body, soluble in boiling alcohol and in benzol, and fusing at 275°; formula—

$$\left.\begin{matrix}C_{14}H_8N\\C_{14}H_9N\end{matrix}\right\rangle O.$$

The communication further includes a lengthy and concisely-written paper on—

Bichlor-Ether.—M. Abeljanz.—The author expects to be able to obtain, from the substance alluded to, the formula of which is—

$$CH_2\text{---}CCl_2\text{---}O.C_4H_5,$$

by the action of pentachloride of phosphorus, a compound—

$$CH_2\text{---}CCl_3.$$

Atomistic Size and Quantivalence of Silver.—Professor Wislicenus.

Journal für Gasbeleuchtung, first number for January, 1871.

Since the beginning of this year this periodical has been published fortnightly instead of, as heretofore, monthly. This number contains the following original paper relating to chemistry and allied sciences:—

On Hydrotimetry and German Degrees of Hardness.—E. Reichardt.—This paper contains a review of the different values assumed by various authors for expressing the degree of hardness of water, and the different modes of testing in use. The author sets forth that, instead of taking carbonate of lime as unit, it is preferable to take lime, CaO, and to make 1 part of that base in 100,000 parts of water =1 degree.

Second number for January, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

What Method of Water Analysis is the Best for Practical Use; Observations on Hydrotimetry.—Dr. A. Wagner.—This essay is written with the view to enable waterworks' engineers and managers to have a good and easily executable—and, for all practical purposes, reliable—method of testing, qualitatively and quantitatively, by gravimetrical method, the quality of the water of their works, as well as of the sources these are supplied from.

Instrument intended for the Measurement of the Size of Gas Flames.—H. Von Wolfsberger.—This paper, illustrated by a woodcut, contains the description and mode of employing a contrivance intended for the correct measurement of gas flames. The instrument may be obtained from the Société Genevoise pour la Construction d'Instruments de Physique, Chemin Courgas No. 113, Genève, Switzerland; the price is about £4.

Arrangement of the Reservoirs and Water Supply Pipes and Hydrants in the New Opera Building at Vienna.—A. Folsch.—A valuable contribution to the best methods of guarding against fires in theatres.

Projected Plans, Specification, and Conditions upon and according to which the Communal Goyernment of Vienna desires to take in hand the Public and Private Gas Supply of that City.—Dr. N. H. Schilling.—This lengthy document, very clearly and precisely drawn up, is worthy the notice of all who are interested in such matters, and the more so as the paper bears evidence of the very high degree of efficiency, and advanced state of Communal Administration, also, in the Austro-Hungarian Empire.

NOTES AND QUERIES.

Tin Pipe.—Can any reader of the Chemical News tell me where pure tin pipe is to be obtained? I want it to convey distilled water in a laboratory.—F.C.S.

Writing Ink.—Will you kindly inform me in the Chemical News how to make a good writing ink so that it will copy well and write of a greenish colour; I think the green shade is owing to the indigo which is put in. I wish it to appear clear when copied?—H. Pitt.

Welding Steel and Iron.—Perhaps some of the contributors to your very appreciable journal might oblige one of its constant readers with the communication of a good process whereby cast-steel and iron might be welded together?—W. A. Murray.

Tattooed Marks.—(Reply to "Scotia.")—As far as we have been able to ascertain, by reference to what is published on tattooing, there appears to be no possibility of erasing the marks. These are usually made by such means as to penetrate to the cutis of the body, where they become indelible.

Determination of Sulphur in Cast-Iron, &c.—Will Mr. Elliott, who published a process for the determination of sulphur in cast-iron (Chemical News, vol. xxiii., p. 61), kindly state whether the solutions remaining in the flask and the insoluble residues were tested for sulphur, and, if so, the result?—S. G. C.

Production of Wood Spirit.—I see, in Chemical News, vol. xxiii., p. 91, you have given an abbreviated account of the production of wood spirit from a paper by Mr. E. T. Chapman; particulars, however, respecting the final treatment of the products of distillation are omitted. Could you kindly supply the omitted particulars?—John F. Earss, B.A.

Laughing Gas.—We read at vol. ii., p. 113 (1871), of Dr. Dobell's "Reports on the Progress of Medicine in Various Parts of the World," that the Messrs. Coxeter have constructed wrought-iron vessels of a cylindrical form, and furnished with a stopcock and proper appliances for inhaling the nitrous oxide gas contained in the iron vessels in a liquefied state. The largest vessel contains 100 gallons of the gas (liquefied, and under the pressure alluded to in our last number), although the vessel is but 12 inches long by 3¼ inches in diameter, and the weight only 9 lbs. 1 oz.

Reduction of Titanium.—In Watts's "Chemistry," and in Berzelius, it is stated that titanic oxide can be reduced to the metallic state if mixed with one-sixth of its weight of charcoal, and submitted, in a covered crucible, to the action of an intense heat. From some experiments I have made, I doubt this. In the first place, if the following equation be correct:—$TiO_2+2C=Ti+2CO$, the equivalent weight of charcoal should be 2-7ths of the titanic oxide. I have exposed mixtures in such proportions to the action of a full white heat for several hours, and obtained, as I believe from the reactions, not metallic titanium, but a mixture of TiO + C. In conclusion, I should feel obliged if any of your correspondents who may have repeated the experiments described in Watts and Berzelius would state whether their experience coincides with mine, or not.—S. T.

MEETINGS FOR THE WEEK.

Monday, 20th.—Medical, 8.
—— London Institution, 4.
Tuesday, 21st.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
—— Ethnological, 8.
—— Zoological, 9.
Wednesday, 22nd.—Society of Arts, 8.
—— Geological, 8.
Thursday, 23rd.—Royal, 8.30.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— Royal Society Club, 6.
—— London Institution, 7.30.
Friday, 24th.—Royal Institution, 9. Prof. Clerk Maxwell, on "Colour."
—— Quekett Microscopical Club, 8.
Saturday, 25th.—Royal Institution, 3. Mr. O'Neil, "On the Spirit of the Age."

TO CORRESPONDENTS.

*** Vol. XXII. of The Chemical News, containing a copious index, is now ready, price 11s. 8d., by post, 12s. 2d., handsomely bound in cloth, gold-lettered. The cases for binding may be obtained at our office, price 1s. 6d. Subscribers may have their copies bound for 2s. 6d. if sent to our office, or, if accompanied by a cloth case, for 1s. Subscribers wishing to complete their sets of volumes are requested to apply to the publisher, who will give them information respecting scarce numbers and volumes. Vol. xxiii. commenced on January 6th, and will be complete in twenty-six numbers. Reading Cases, price 1s. 6d. each post free, may also be obtained at the Office.

W. N. Evans.—We do not know Dr. Gunther's address. By applying to Asher and Co., Foreign Booksellers, Bedford Street, Covent Garden, you may perhaps ascertain if the paper has been published as a pamphlet or not.

W. J. Reynolds.—The analyses are official, and are still inserted in the Chemical News when they are sent.

J. Lowe.—We do not know; apply to one of the medical papers.

A. Payne.—"A Practical Treatise on Coal, Petroleum, and other Distilled Oils," by A. Gesner, M.D., published by Baillière Bros., New York; or "The Manufacture of Photogenic or Hydrocarbon Oils from Coal and other Substances, by T. Antisell, M.D., published by Appleton and Co., New York.

Just published, with 90 Engravings on Wood, 8vo., 10s. 6d.

A Laboratory Text-Book of Practical Chemistry; or, Introduction to Qualitative Analysis; a Guide to the Course of Practical Instruction given in the Laboratories of the Royal College of Chemistry. By Wm. G. Valentin, F.C.S.

J. and A. Churchill, New Burlington-street.

Just published, price 2s. 6d.,

Sewage Irrigation; a Lecture, by W. Hope, Esq., V.C., delivered to the Ratepayers of West Derby (near Liverpool). With Plan, printed in colours.

London: Edward Stanford, 6 and 7, Charing Cross, S.W.

Now ready, price 6d.,

Notes of Professor Odling's Juvenile Lectures on BURNING AND UNBURNING, delivered at the Royal Institution of Great Britain, Christmas, 1870-71.

London: Chemical News Office, Boy Court, Ludgate Hill, E.C.

THE CHEMICAL NEWS.

VOL. XXIII. No. 591.

ON THE ACTION OF HYDROBROMIC ACID ON CODEIA.

By C R. A. WRIGHT, D.Sc.

IT has been shown by the late Dr. A. Matthiessen, in conjunction with the writer,† that when codeia is heated with a large excess of strong hydrochloric acid the following reactions successively take place:—

$$\underset{\text{Codeia.}}{C_{18}H_{21}NO_3} + HCl = H_2O + \underset{\text{Chlorocodide.}}{C_{18}H_{20}ClNO_2}.$$

$$\underset{\text{Chlorocodide.}}{C_{18}H_{20}ClNO_2} = CH_3Cl + \underset{\text{Apomorphia.}}{C_{17}H_{17}NO_2}.$$

It appeared of interest to examine the action of hydrobromic acid under similar circumstances, and for this purpose, Messrs. Macfarlane, of Edinburgh, with their wonted liberality, put a considerable quantity of pure codeia at the writer's disposal.

The aqueous hydrobromic acid employed was obtained by the action of H_2S on Br in presence of water, and subsequent rectification over pulverised KBr; it was free from SO_4H_2 and other sulphur compounds, had a sp. gr. of about 1·5, and contained about 48 per cent of HBr.

When codeia is heated with from three to six times its weight of this acid, either on a water-bath or to gentle ebullition over a flame, the liquid, which at first produces no precipitate with solution of carbonate of soda, gradually darkens in colour, and acquires the property of yielding a dense white precipitate with this reagent. No appreciable quantity of methyl bromide is evolved during the first stages of this change, but subsequently this body is produced in some little quantity.

The precipitate thrown down by carbonate of soda before this further change ensues, appears to consist of a variable mixture of at least three substances, two of which are readily soluble in ether, while the third is but sparingly soluble in that menstruum; all are bases, the one insoluble in ether, and one of those soluble containing bromine: the one apparently first formed is produced by a reaction precisely analogous to that whereby chlorocodide is generated, viz.,—

$$\underset{\text{Codeia.}}{C_{18}H_{21}NO_3} + HBr = H_2O + \underset{\text{Bromocodide.}}{C_{18}H_{20}BrNO_2},$$

and is, therefore, termed bromocodide; this base appears to be acted on further with great ease, giving rise ultimately to the other two, the first of which has the constitution of codeia less one equivalent of oxygen, or $C_{18}H_{21}NO_2$, and is, therefore, provisionally named deoxycodeia; whilst the second has the composition of four molecules of codeia coalesced together, one of the 84 H atoms in the product being replaced by Br; it is, therefore, provisionally termed bromotetracodeia, the simplest mode of representing the simultaneous formation of these two bases being as follows:—

$$\underset{\text{Bromocodide.}}{C_{18}H_{20}BrNO_2} + 4\underset{\text{Codeia.}}{C_{18}H_{21}NO_3} =$$

$$= \underset{\text{Deoxycodeia.}}{C_{21}H_{21}NO_2} + \underset{\text{Bromotetracodeia.}}{C_{72}H_{83}BrN_4O_{12}}.$$

Owing to the ease with which bromocodide is altered, it is a matter of some difficulty to obtain it in even an approximately pure condition, as the complete separation of deoxycodeia appears impracticable when this base has once been produced. The product of the action of three parts 48 per cent acid on one part codeia on the water-bath for from one to two hours is precipitated by excess of sodium carbonate, and the precipitate collected on filters; unaltered codeia is for the most part separated thus, being contained in the filtrate. Extraction of the mass with ether and agitation of the ethereal solution with HBr furnishes crude bromocodide hydrobromate, which may be purified by a repetition of the process, fractional precipitation being resorted to to get rid of traces of colouring-matters; the purified hydrobromate thus obtained was a viscid colourless liquid which utterly refused to crystallise, and dried up to a gum-like mass over SO_4H_2. Dried at 100°, the powdered gum gave these numbers*:—

0·3500 grm. gave 0·6340 CO_2 and 0·1580 H_2O.

0·230 grm. boiled with NO_3H and $AgNO_3$ gave 0·1900 Ag Br.

	Calculated.		Found.	
C_{18}	216	48·76	49·40	
H_{21}	21	4·74	5·01	
Br_2	160	36·12	..	35·08
N	14	3·16		
O_2	32	7·22		
$C_{18}H_{20}BrNO_2HBr$	443	100·00		

The slight excess of carbon and deficiency in bromine thus found are doubtless due to the presence of a little deoxycodeia, the hydrobromate of which requires 59·34 per cent carbon and 21·98 per cent Br. Another specimen of bromocodide hydrobromate, prepared as above from the product of three hours' digestion at 100° of one part codeia and three parts 48 per cent HBr, yielded numbers indicating 51·6 per cent carbon, 5·3 and 33·4 per cent Br; whilst a repetition of the purification process scarcely altered the numbers. Owing to the great difficulty in preparing the pure salt in quantity, no attempt to isolate and analyse the base itself was made, the more so that the precipitate thrown down by carbonate of soda from the pure hydrobromate appeared to tally in every respect with the chlorocodide formerly examined; their qualitative reactions, too, are identical.

The crude bromocodide hydrobromate obtained after five or six hours' digestion of codeia with from three to five times its weight of 48 per cent HBr deposited on standing for some days crystals not readily soluble in cold water; recrystallised several times from boiling water, minute snow-white crystals were ultimately obtained; these slightly darkened on drying over SO_4H_2, and more so at 100°, and gave the following numbers on analysis:—

0·3565 grm. gave 0·7760 CO_2 and 0·1960 H_2O.

0·3245 grm. gave 0·7045 CO_2 and 0·1790 H_2O.

0·2200 grm. burnt with soda-lime gave 0·0570 Pt.

0·1380 grm. boiled with NO_3H and $AgNO_3$ gave 0·0700 AgBr.

These numbers agree with those calculated for deoxycodeia hydrobromate, as the following comparison shows:—

	Calculated.		Found.		
C_{18}	216	59·34	59·36	59·21	
H_{22}	22	6·05	6·11	6·13	
N	14	3·84	..	..	3·69
O	32	8·79			
Br	80	21·98	..	..	.. 21·59
$C_{18}H_{21}NO_2HBr$	364	100·00			

The yield of this base from the codeia used being but small (about 4 per cent), no attempt was made to isolate the base itself; carbonate of soda throws down from the hydrobromate solution a white precipitate which is soluble in alcohol, ether, benzol, and chloroform; by exposure to air it rapidly becomes coloured, and finally acquires a very dark green tint. Its qualitative reactions are identi-

* Read before the Royal Society, March, 1871.

† *Proceedings of the Royal Society*, vols. xvii., p. 460; xviii., p. 83.

* All combustions given in this paper were made with lead chromate and finished in a stream of dry oxygen.

cal with those of apomorphia; the colour-reactions of the two with Fe_2Cl_6, NO_3H, and $SO_4H_2+K_2Cr_2O_7$, being indistinguishable when examined side by side. Its physiological effects, however, are different; three-tenths of a grain of the hydrobromate administered by the mouth to a dog producing no appreciable effect, whilst a much less dose of apomorphia produces speedy vomiting.

The third base is conveniently obtained, as hydrobromate, by treating codeia with three times its weight of 48 per cent HBr for two hours on the water-bath, precipitating the product (diluted with water) by excess of carbonate of soda, collecting on filters, and well draining from the mother-liquors, and finally extracting with ether until scarcely anything more is taken up; care must be taken to have as little watery fluid as possible present, otherwise the insoluble substance forms a sort of lather on agitation from which the ether will not separate. The insoluble substance is then dissolved in the least possible quantity of weak hydrobromic acid and fractionally precipitated by cautious addition of stronger acid; the second precipitate is dissolved up in water, in which it is readily soluble, and a few drops of carbonate-of-soda solution added. The filtrate from this yields, with strong HBr, nearly white flakes, which are wholly void of crystalline character under the microscope. These remain solid at 100° if previously completely dried over SO_4H_2; but if warmed while moist, become a more or less coloured tar. Dried at 100°, the following numbers were obtained:—

0·3440 grm. gave 0·6810 CO_2 and 0·1740 H_2O.
0·3425 grm. gave 0·6685 CO and 0·1680 H_2O.
0·5615 grm. burnt with soda-lime gave 0·1310 Pt.
0·3200 grm. boiled with NO_3H and $AgNO_3$ gave 0·1330 AgBr.
And 0·0315 Ag.

	Calculated.		Found.	
C_{72}	864	54·03	53·99	53·23
H_{87}	87	5·44	5·61	5·45
N_4	56	3·50	..	.. 3·33
O_{12}	192	12·01		
Br_5	400	25·02	..	.. .. 24·97
$C_{72}H_{83}BrN_4O_{12},4HBr$	1599	100·00		

Carbonate of soda throws down from the hydrobromate a nearly white precipitate, which rapidly darkens, and finally turns a deep green, nearly black. Dried at 100° rapidly, the product gave the following numbers, which fall below those required for the formula $C_{72}H_{83}BrN_4O_{12}$, but which agree with those required for a similar formula but containing more oxygen:—

0·3810 grm. gave 0·8460 CO_2 and 0·2080 H_2O.
0·4430 grm. boiled with $AgNO_3$ and NO_3H gave 0·059 AgBr.

	Calculated.		Found.	
C_{72}	864	60·89	60·56	
H_{83}	83	5·85	6·07	
Br	80	5·64	..	5·67
N_4	56	3·95		
O_{12}	336	23·67		
$C_{72}H_{83}BrN_4O_{12}+O_9$	1419	100·00		

It hence appears that the free base rapidly absorbs oxygen. In confirmation of this, 0·11 grm. of the hydrobromate treated with caustic potash and injected by a pipette into 15 c.c. of air over mercury absorbed 0·9 c.c. in the course of an hour, or 6 per cent of the total volume of the air; the salts, however, when dry, may be kept without alteration, and only slowly darken by exposure to air when moist.

This welding together of four molecules is not wholly without parallel in the history of the opium alkaloids; and their derivatives thus opianic acid heated* furnishes a body containing four times as much carbon as the original acid; thus—

$$4C_{10}H_{10}O_5 = H_2O + C_{40}H_{38}O_{19}.$$

The qualitative reactions of bromotetracodeia appear to be identical with those of bromo- and chlorocodide. The base itself, when freshly precipitated, is slightly soluble in water, being thrown down again by addition of strong brine; in ether and benzol it is almost insoluble, and in alcohol but sparingly soluble.

When crude bromotetracodeia, got by extraction with ether of the mixture of bases thrown down by carbonate of soda, is dissolved in weak hydrochloric acid and precipitated twice or thrice by excess of stronger acid, nearly white flakes are ultimately obtained, resembling in all their physical properties the bromohydrobromate of tetracodeia. These flakes, however, contain no bromine, the absence of this element being ascertained by the negative results obtained on examining with chlorine-water and ether the acidified solutions of the lime-salts got by combustion with quicklime, and of the sodium-salts got by boiling with NO_3H and $AgNO_3$, and fusing with carbonate of soda the silver-salts thus got. Dried over SO_4H_2 and finally at 100°, this body gave numbers indicating a base of constitution analogous to that of bromotetracodeia; it may, therefore, be termed chlorotetracodeia.

Specimen A.

0·3880 grm. gave 0·1970 AgCl.
0·3645 grm. gave 0·8395 CO_2 and 0·2120 H_2O.
0·3940 grm. burnt with soda-lime gave 0·1080 Pt.

Specimen B.

0·4460 grm. gave 0·0150 CO_2 and 0·2560 H_6O.
0·2350 grm. gave 0·1250 AgCl.

	Calculated.		Found.	
			Specimen A.	Specimen B.
C_{72}	864·0	62·77	62·81 ..	62·07
H_{97}	87·0	6·32	6·46	6·38
N_4	56·0	4·07	.. 3·90	
O_{12}	192·0	13·94		
Cl_5	177·5	12·90	12·56 ..	.. 13·16
$C_{72}H_{83}ClN_4O_{12},4HCl$	1376·5	100·00		

Specimen A had been three times precipitated by HCl in large excess, while specimen B had only been thrown down twice, and probably retained a trace of bromotetracodeia.

Specimen A converted into platinum-salt gave the following numbers after drying at 100°.

0·4215 grm. gave 0·0810 Pt = 19·22 per cent.

The formula $C_{72}H_{83}ClN_4O_{12},4HCl,2PtCl_4$ requires 19·18 per cent.

Like bromotetracodeia, the free base appears to absorb oxygen with avidity. Dried as rapidly as possible at 100°, the precipitate thrown down by carbonate of soda gave these numbers:—

0·3880 grm. gave 0·9190 CO_2 and 0·2230 H_2O.
0·3100 grm. gave 0·0330 AgCl.

	Calculated.		Found.	
C_{72}	864	64·74	64·59	
H_{83}	83	6·22	6·38	
N_4	56	4·20		
$O_{18\frac{1}{2}}$	296	22·18		
Cl	35·5	2·66	..	2·64
$C_{72}H_{83}ClN_4O_{12}+O_{6\frac{1}{2}}$	1334·5	100·00		

In all its physical and chemical properties chlorotetracodeia closely resembles bromotetracodeia: their qualitative reactions are identical; they have an intense bitter taste and apparently but slight physiological action, at any rate in small doses.

My thanks are due to Mr. I. L. Bell, in whose laboratory the above experiments were carried out.

* Matthiessen and Wright, *Proceedings of the Royal Society*, vol. xvii., p. 341.

ON THE

CHANGE EXPERIENCED BY METALLIC IRON AND BY IRON OXIDES WHICH HAVE SERVED TO DISSOCIATE CO.*

By I. LOWTHIAN BELL.

Expt. 331.—A weighed quantity of pure Fe_2O_3 was placed in a boat in a porcelain tube, heated by a Hofmann's furnace. By means of a T-tube, furnished with screw pinch-cocks, either H or CO could be admitted at pleasure from their respective sources—viz., zinc and sulphuric acid for the one, and ferrocyanide of potassium and sulphuric acid for the other. Precautions were employed for purifying and drying the gases, and which, therefore, may be assumed as arriving at the Fe_2O_3 in a perfectly pure state. All air was expelled from the apparatus, CO generator included, by a long-continued stream of hydrogen; the porcelain tube was then heated, and the H_2O produced collected and weighed. During this time the CO generator was giving off CO, but the gas was permitted to escape through a side valve. When the ferric oxide was completely reduced (known by no more H_2O being produced after several minutes' passage of H), the H was shut off, and the CO turned on.

	Grms.
5·487 grms. of pure Fe_2O_3, exposed to H, gave H_2O	1·858
The theoretical quantity of H_2O being	1·852

CO was then passed over the reduced iron for 4½ hours at a temperature of melting zinc—the residual mass was dissolved in HCl, and the carbon left weighed 0·78 grm., equal to 20·3 per cent of the Fe present.

Expt. 332.—3·497 grms. of pure Fe_2O_3, heated in H, yielded, in one hour, of H_2O.. .. .. .. 1·189

In ten minutes more, additional ..	0·001
,, ,, ,, ..	*nil.*
Total	1·190
Theoretical water being ..	1·1802

CO passed over it for one hour at a very dull red heat, gave, of carbon, 0·0584, equal to 23·8 per cent on the Fe.

Expt. 333.—3·497 grms. of pure Fe_2O_3 gave same results as above when treated with H, no more H_2O being produced after twenty-five minutes' passage of gas. The spongy iron was then exposed to CO at a low red heat for two and a half hours. The carbon deposited was determined by combustion in oxygen, with a tube in front, containing red-hot CuO, to prevent loss by formation of CO. The CO_2 corresponded to 0·313 grm., equal to 12·3 per cent of carbon on the Fe present.

In this last instance, the higher temperature has materially lessened the carbon deposition, inasmuch as, although the operation lasted two and a half times as long as the previous trial, the C obtained is a mere fraction above half that in Experiment 336.

Believing it improbable that the metallic spongy Fe should have been instrumental in resolving CO into C and CO_2, without itself suffering some change, the various steps of the process were narrowly watched. In some experiments, after the spongy iron had been exposed to CO for a known time, H was again passed through the tube by means of the arrangements of pinch-cocks and T-tube, formerly described. In all these cases, there was a formation of H_2O, the oxygen of which could have only come from CO. In other experiments, the CO_2 formed by the action of the CO on the spongy iron was collected and weighed, and the residual carbon was likewise determined. This latter was always in excess of the former, showing that a hypothetical splitting-up of 2CO into C and CO_2 would not alone account for the observed facts. In other instances, again, the tube was allowed to cool in a stream of CO, the residual mass weighed, and the deposited carbon determined; the iron present being known from the weight of the pure Fe_2O_3 used. It was always found that the Fe and C together fell short of the actual weight of the residual substance, showing that it must have contained oxygen in addition.

Expt. 334.—2·448 grms. spongy Fe from Fe_2O_3 reduced by H:—

	Grm.
CO_2, collected during passage of CO for one hour at a very dull red heat..	0·214
CO_2 produced on combustion of carbonaceous mass in oxygen	0·237
Difference	0·023
This represents, of carbon	0·006
Originally associated with, of oxygen	0·008

This amount of oxygen must therefore have been taken up by the spongy iron; in confirmation of this, 0·0065 grm. of H_2O were collected, on passing hydrogen a second time over the carbonaceous mass (previous to its combustion in oxygen), corresponding to, of oxygen, 0·006 grm.

The slight discrepancy between this number and that got before, 0·008, arises from the impossibility of collecting the CO_2 contained in the large excess of CO without slight loss, either from deficient absorption, or from the removal of traces of aqueous vapour from the potash bulbs.

Expt. 335.—The residual iron oxide left in the last experiment, after burning off the carbon in oxygen, was again thoroughly reduced in H, then exposed to CO at a low red heat for two and a half hours.

	Grms.
H_2O, produced by sccond passage of H, 0·023 grm., representing of oxygen	0·0204
Weight of residual iron and carbon	2·7590
Weight of iron in 3·497 Fe_2O_3	2·4480
Leaving, for carbon deposited	0·3110
And the carbon, as determined by combustion, was	0·3130

Expt. 336.—The weight of residual Fe+C+O obtained after reducing the 5·487 grms., Fe_2O_3 mentioned in Experiment 331, and then exposing it to CO for four and a half hours, was .. .. 4·707 grms.

Fe in 5·487 Fe_2O_3 is	3·841 grms.	—
C left on solution in HCl ..	0·780 ,,	4·621 ,,
Leaving for O taken up by Fe	0·086 ,,	

These last experiments yield the following numbers, calculated upon 100 parts of metallic iron present:—

	A.	B.	C.
Time of exposure to CO	1 hour.	2½ hours.	4½ hours.
Temperature	Very dull red.	Low red heat.	Melting zinc.
Oxygen in reformed iron oxide.. ..	0·34 0·24	0·84	2·24
Carbon deposited ..	2·64	12·7—12·8	20·3

It would, therefore, seem that the amount of reformed oxide increases with the quantity of deposited carbon. This increase, however, may not be in a perfectly corresponding ratio, owing to the power of CO to reduce the newly-formed oxide, varying at different temperatures. The proportion of oxygen absorbed by the iron for each 100 parts of carbon deposited, is for—

A.	B.	C.
10.	6·6.	10.

So that, as the temperatures at which the operation has been carried on approach each other, as happened in the case of A and C, the ratio between carbon deposited and oxygen absorbed are the same, viz., about 7 equivalents of the former to 1 of the latter, and the equation would stand thus, provided the oxide of iron were protoxide, which is not certain:—

$$13CO + Fe = 7C + FeO + 6CO_2.$$

As the temperature rises, spongy iron exerts but little action on CO. Precipitated Fe_2O_3, after complete reduc-

* From the "Chemical Phenomena of Iron Smelting."

tion by H, was exposed to a stream of CO, at a bright red heat: after one hour's exposure, the composition of the substance was—

	Fe.	C.	O.
Expt. 337.	99·20	0·32	0·48
And after three hours more ..	99·34	0·30	0·36

In such cases as the present, either the CO_2, generated by the splitting up of CO quickly gasefies at high temperatures the deposited carbon directly, or, what is more probable, the acid itself is resolved into CO by yielding O to the metal, and the oxide of iron, so formed, is again reduced by carbon previously precipitated.

The presence of CO_2 in the CO of course intensifies the oxidising influence of the mixtures, and although some carbon may be deposited, the absorption of oxygen predominates.

(To be continued).

ON THE CULTIVATION OF MADDER IN DERBYSHIRE.*

By JOSEPH SIDEBOTHAM, F.R.A.S.

SEVERAL attempts have been made to cultivate madder in England and Ireland, but the records of the experiments are very meagre and unsatisfactory, and one can only judge their want of success from the fact that they are not repeated.

Being desirous of ascertaining the capabilities of our soil and climate for this branch of farming, and having suitable land at our disposal at Strines, Mr. Nevill and I determined to try the experiment, the results of which I have now the honour to lay before you.

In order to make the matter plain to those who do not understand the different qualities of madder, it is necessary to give a few words of explanation.

Madder is the root of *Rubia tinctoria* by some authorities supposed to be a mere cultivated variety of a plant indigenous to this country, and found wild in many places in the limestone districts on rocks and walls. This plant is cultivated for the purpose of dyeing in many parts of Europe and in India.

Its qualities vary much; that from Holland, called Dutch madder, will dye red, but not purple, and the colour is not fast; that from Italy, call Naples madder, dyes good reds and purples, but the colour is also loose; that from Turkey dyes good reds and purples, and is very fast; from France we get two qualities, called respectively rosés, from their dyeing beautiful reds and pinks, and paluds, the latter being a name given because the roots are grown on marshy land. The latter yield, besides the fine reds, also a good purple, nearly allied to that produced by Turkey roots.

For the purpose of the experiment we selected a piece of rich land, near the river, at Strines, a little less than an acre, and having prepared it in the usual manner, we had it sown with seed from fine palud madder, early in the spring of 1868. The weather was unusually dry and the ground produced a crop of remarkably fine *Polygonum aviculare*, which almost choked the young madder seedlings. (I am inclined to think the seed of this *Polygonum* were mixed with the madder seed.) In the autumn the madder plants came into flower, and the roots of some pulled up measured 13 inches in length.

The field was weeded, and the plants came up in the spring of 1869, very strong and healthy, and so on until August, 1871, when we had them dug up. To produce the best results the roots should have remained another year in the ground, but for the purpose of our experiment this growth was considered sufficient. As to yield, the quantity produced was small, probably owing to the very dry season after sowing; in appearance and size the roots were about equal to fine French roots, but on breaking them, instead of the deep red colour in the best French roots these were orange, or yellow.

The dyeing properties were of a very disappointing nature: out of the dye the colours looked full, but on being cleared with soap they were found to be loose, and precisely in character like Dutch madder, the reds and pinks being weak and loose, and the purple element entirely wanting. From a single experiment it would be unwise to do more than hazard an opinion, as more extended experiments might lead to other results; but I think it probable that the deficiency of colouring matter in these English madder roots is owing to a deficiency of sun and heat. It would not be easy in this country to select a more likely soil for the purpose than that of Strines, and the seed was obtained from a district where the best quality of French madder is grown.

It is said to be a fact that French seed, when sown in Holland does not produce a French quality of roots, but one similar in every way to the usual Dutch madder. This, if correct, would support my opinion.

I have here to illustrate this subject, specimens of the various madders in the root and ground state, also the colours produced by each, and the relative degree of fastness exhibited by portions of each being subjected to boiling soap.

* Read before the Manchester Literary and Philosophical Society, February 7th, 1871.

THE ACTION OF SULPHUROUS ACID ON PHOSPHATES.

By Dr. B. WILHELM GERLAND.

THE researches which this paper describes lead to the following conclusions:—

(1). An aqueous solution of sulphur dioxide acts upon several phosphates, not by decomposing them, like other strong acids, but by combining with them, forming soluble compounds. Basic phosphates require from 4 to 6, and neutral phosphates 2 mols. of sulphur dioxide for solution. These solutions part less readily with their sulphur dioxide than the simple aqueous solution of the latter, and those of the neutral phosphates more easily than those of the basic phosphates. From some of these solutions the original phosphate can be again obtained, from others a less basic salt, but the decomposition in the solutions of this class does not proceed to the formation of phosphoric acid.

The following phosphates belonging to this class have been examined.

(*a*). Tricalcium phosphate is abundantly soluble in water and sulphur dioxide. The concentrated solutions undergo a slow decomposition at temperatures above 18° C., and form besides calcium sulphite, dicalcium- and monocalcium-phosphate. Both concentrated and dilute solutions deposit mixtures of calcium sulphite and dicalcium hydric phosphate by addition of alcohol, by exposure in vacuum, or by boiling under reduced pressure. Boiling under atmospheric pressure, on the other hand, causes the formation of the new compound: tricalcium phosphate sulphite, $Ca_3P_2O_8,SO_2,2H_2O$, as a crystalline precipitate which is distinguished from the above-mentioned mixtures of dicalcium phosphate and calcium sulphite by its great stability. It claims more general interest as being an active manure and disinfectant. The unusual composition of this substance made it desirable to prepare corresponding compounds of other metals, but all attempts in that direction have been unsuccessful.

Dicalcium hydric phosphate is readily soluble in water charged with sulphur dioxide. From the solution the original phosphate can be easily obtained.

* Read before the Manchester Literary and Philosophical Society March 7th, 1871.

(*b*). Trimagnesium-, dimagnesium-, and magnesium-ammonium- phosphate are dissolved in large quantities by water charged with sulphur dioxide; the first two without decomposition, but if an excess of the latter has been used, dimagnesium hydric-phosphate is left undissolved. All these solutions have a great tendency to deposit dimagnesium hydric-phosphate in crystals.

(*c*). Tri- and di- manganese phosphate are very soluble in sulphur dioxide and water. Both solutions give crystals *in vacuo*, consisting principally of dimanganese phosphate, but by boiling, precipitates of trimanganese phosphate are formed.

(*d*). Copper phosphate is soluble, although in smaller quantity, in an aqueous solution of sulphur dioxide without decomposition. The solution deposits at a summer temperature in course of time crystals of cuprous and cupric-sulphite, and by boiling, cupric phosphate.

(*e*). Uranium phosphate is very slightly soluble in water charged with sulphur dioxide. The phosphate of the original composition separates again from the solution after the removal of the sulphur dioxide.

(*f*). Crystals of trisodium phosphate absorb sulphur dioxide in such quantity that it would suffice to convert all the sodium present into sodium hydric sulphite. However, alcohol separates sodium dihydric phosphate from the solution, and less than 5-6ths of the sulphur dioxide are expelled by boiling. The concentrated solution obtained by saturating the crystals with the gas, shows the peculiar phenomenon of separating into two distinct liquids by gravitation; agitation unites these again to a perfectly homogeneous liquid.

(2). Sulphur dioxide in aqueous solution has no action upon bismuth-, stannous-, stannic-, and metastannic-phosphate.

(3). Sulphur dioxide and water act upon some phosphates in the same manner as other strong acids by forming a sulphite and phosphoric acid. The phosphates of barium, silver, and lead have been observed to undergo this decomposition.

(4). Calcium arsenite, calcium arseniate, and cupric vanadate are dissolved like the first group of phosphates, without decomposition by sulphur dioxide and water. The solution of the first forms calcium sulphite by boiling, the second begins soon to deposit calcium sulphate, owing to the reaction of arsenic acid on sulphurous acid, and the solution of the vanadate on boiling deposits beautiful golden coloured scales, which are, probably, copper vanadite sulphite.

(5). Calcium oxalate is dissolved, in very minute quantity, by water charged with sulphur dioxide, and is deposited unchanged after expulsion of the gas.

THE MAXIMUM DYNAMIC EFFECT OF A GALVANIC BATTERY.

By the Rev. H. HIGHTON, M.A.

I FIND that the views I have advocated in the CHEMICAL NEWS and *Quarterly Journal of Science* on this subject, have, as might have been expected, been attacked in America by Prof. Phin, in the *Technologist*, and ably, and in my opinion very successfully, defended by a writer who signs himself "Dynamics." But I find the same confusion prevailing on the other side of the Atlantic as on this, on the subject of the advantages of the equality of the external and internal resistances of a battery. Let me, then, briefly tabulate the true theory on this point.

1. If we have a given external resistance, and a given number of cells, or given area of (say) zinc and platinum, the greatest *intensity* of current is gained by so arranging the cells, or cutting up the area of zinc and platinum into so many parts, that the external resistance shall be equal to the internal. Also this arrangement gives the greatest heat in the *external* circuit, but not in the *total* circuit.

(2). The greatest *heat* in a given time is produced in the *whole* circuit (on the same data) with the cells arranged wholly for intensity, or the zinc and platinum cut into as many pieces as possible.

(3). If we have a given battery working in a certain manner, the greatest *intensity*, and also the greatest heat in a given time in the whole circuit is produced by the external wire being as short and thick as possible.

(4). On the same data the greatest *heat* in a given time is produced in the external part of the circuit when the external and internal resistances are equal.

(5). The greatest *magnetic power* is produced when the external wire is as long and thick as possible.

I will not go through the mathematical proofs of these five rules, but will leave it for mathematical electricians to work them out each for himself.

ON THE VARIOUS TINTS OF AUTUMNAL FOLIAGE.

By H. C. SORBY, F.R.S., &c.

IN the following paper I shall endeavour to explain the production of all that variety of colour which imparts such a charm to woodland scenery in autumn. I must, however, frankly admit that very much yet remains to be learned. The complete study of the question would involve very much research, and I see the importance of examining the colouring matters in spring and summer now that it is too late. Still, however, I trust that I shall be able to give a tolerably satisfactory general account of the subject, and, perhaps, little more is desirable on this occasion, since that may interest many who would not care to occupy their time in studying in detail the optical characters of the colouring matters found in leaves. These are certainly very numerous, and I have even so far established the existence of about a score, though I have examined only a few dozen plants with the requisite care. These have, however, been chosen in such a manner as to show the more striking phenomena, and probably a more extended examination would merely reveal a greater number of different colours, without materially altering the general results.

In the first place, I must say that it appears very desirable to divide the various colouring matters into different groups or genera, each of which includes a number of distinct substances or species having some well-marked peculiarity in common. I shall not attempt to give anything like a complete account of the characteristic difference of the various species, since that would involve a long and tedious description of minute particulars, and shall confine my remarks to such prominent facts as are of importance in the subject more especially before us, and can be described without illustrations or very technical notation. I scarcely need say that such an inquiry could not possibly be carried out by any other than the spectrum method. Chemical analysis would be of very little use, and might easily lead us to conclude that different substances were the same, and the same different. It also is especially useful in studying the complicated mixtures with which we have to deal, since particular substances can be easily recognised when it would be quite impossible to obtain them in a separate state. For a more complete description of this method of research I beg to refer to what I have already published on animal and vegetable colouring matters,* and on some technical applitions of the spectrum microscope.† I may also say that, spending, as I do, several hours nearly every day amongst the woods, fields, and moors, I have had good opportunity for studying the application of such inquiries to the subject before us.

* *Proceedings of the Royal Society*, vol. xv., p. 433.
† *Quarterly Journal of Microscopical Science*, New Series, vol. ix., p. 358.

The group of colouring matters which first of all claims our attention is that which may be distinguished by the term *chlorophyll*. It has often been treated as if it were one simple substance, but optical examination proves the existence of a number of separate species. The leaves of most plants are coloured green by a mixture of two or more of these. One kind occurs in a state of comparative purity in the small aquatic plants allied to *Oscillaria*, and the green leaves of trees appear to contain this along with one which gives special absorption-bands. Another is the product of the action of acids on these, and occurs naturally in some leaves, especially when turned brown in autumn, and this gives rise to a very special spectrum with numerous bands. A fourth, found in faded *Confervæ*, is closely related to the last, but differs in gradually turning to a deep blue colour, when hydrochloric acid is added to the alcoholic solution. All these have the following peculiarities in common—they are insoluble in water, but soluble in alcohol, or bisulphide of carbon: the spectra have all a very well-worked absorption-band in the red, but the green more or less completely transmitted, so that the prevailing tint is a more or less modified green.

The second class of colouring matters may be described as the *xanthophyll* group. These are characterised by being insoluble in water, but soluble in alcohol and in bisulphide of carbon; the spectra show absorption at the blue end, often with more or less well-marked narrow-bands, but the red, yellow, and yellow-green are freely transmitted, so that the general colour is clear yellow or orange. The different species are distinguished by the character and position of the absorption-bands, which are best seen when the colour is dissolved in bisulphide of carbon. A considerable number are found in various fruits, flowers, and roots, but only two are so commonly met with in leaves as to claim attention in this paper. These appear to be the same as the two which give rise to the difference in the colour of the yellow interior and the orange exterior of some carrots. They may be obtained by dissolving in hot alcohol, and agitating the cold solution with excess of bisulphide of carbon, which subsides to the bottom with more or less of the colour, and leaves in the alcohol all other substances soluble in water. Both give spectra with two rather obscure absorption-bands, which lie further from the blue end in the case of colour from the external layer of the carrot, and the colour of this is orange, and of the other yellow. This latter is the kind most commonly met with in yellow leaves, from which it may be obtained in the manner just described, and when nearly pure it is of the same tint as gamboge. The orange colour is more rare, but occurs in leaves fading to a deeper and more orange-yellow, as, for instance, in those of the india-rubber tree, to which it gives a tint closely corresponding to that of Indian-yellow, It also occurs in a more pure state in the ripe envelope of the fruit of the common winter cherry (*Physalis Alkikengi*), to which it gives a still more orange-coloured tint, approximating to that of the exterior layer of the carrot. There may be some other colours besides these having bands in intermediate situations, but, on the whole, I am disposed to regard them as variable mixtures of the two just described.

Since the name of *erythrophyll* has been already applied to the red colour of leaves in autumn, it will be best to adopt it as that of a group containing a number of different species. These may be said to be characterised by their more or less red colour, which is made more intense by acids, and more purple, blue, or green by alkalies. This is because there is a strong absorption in the green part of the spectrum, and the broad band is raised towards the blue end by acids, and lowered towards the red by alkalies, which also often increase the absorption at the blue end, so as to make the colour green, though I am much inclined to believe that, in most cases, this is due to the presence of a second yellow-coloured substance, so that a mere difference in colour is no proof that the red colours differ. Usually, but not invariably, they are soluble in water and aqueous alcohol, but not in bisulphide of carbon. Very many species are met with in fruits, flowers, and roots, distinguished by their spectra, either in their natural state or when acted upon by various reagents, and so far I have found at least six in leaves. That which gives rise to the red patches in the beautiful, variegated leaves of some of the geraniums of our gardens, is the same as that met with in the flowers of particular species. The purple colour of the leaves of turnips is the same as that of the purple flowers of the common garden stock. The colour of red cabbage has well-marked peculiarities, and so has that of the root and leaves of the beet. The dark leaves of *Tamus communis* contain another distinct colour, and so do those of the purple beech, but all these are normal constituents of the young leaves of particular varieties of the plants, and not simply developed towards autumn. It is, however, impossible to draw a line between the two cases, since the colour which gives rise to the dark brown tint of heath in autumn appears to be the same as that of the purple beech, and that which occurs in the dark leaves of ivy seems to correspond with the fine deep pink colour developed in many leaves only in autumn, so as to give rise to the splendid red and scarlet, which produce such a fine effect on certain kinds of scenery.

In order to obtain these red colouring matters in a satisfactory state for experiment, the leaves should be boiled in alcohol, which dissolves chlorophyll, xanthophyll, and the reds; but, as I have already described in previous papers, the alcoholic solution of most of them rapidly fades, so that the solution is only of a dirty green or yellow tint. On evaporating it to dryness, the splendid red colour chiefly collects round the edges, and the chlorophyll and xanthophyll are deposited more in the centre, so that we can immediately see that there is a mixture. By re-dissolving in water, the chlorophyll and xanthophyll are left insoluble, and the erythrophyll is obtained in solution, and on gentle evaporation is left in the state of a dry gum, which in some cases remains almost unchanged for months or even years. It must, however, be borne in mind that, as thus prepared, the erythrophyll must necessarily contain a variable amount of the colours described below, and it is no doubt to their presence that some of the reactions are due, which both myself and others have referred to the red colour itself. Thus, for instance, when they are slightly oxidised, the broad absorption-band is lowered towards the red end, and by further oxidation, the colour becomes more or less orange-yellow, just in the manner that the colour of dark grapes is changed into that of new wine, and this in time to that of very old, as described by me in a paper already cited, but I am now inclined to believe that this further oxidation, which destroys the main absorption-band, extending over the yellow and green, does really completely destroy the colour of the red substance, and that the more or less orange-yellow is due to the oxidisation of a pale yellow colour previously obscured by the deeper red. This fact is of considerable importance in the subject before us, since it explains why intensely red leaves fade to almost, if not exactly, the same tint as those of the like kind which were previously not at all red; that colour being so completely destroyed as to produce no effect on the tints subsequently developed.

The fourth group of colours is composed of those soluble in water and aqueous alcohol, but insoluble in bisulphide of carbon, which have a sufficiently decided gold yellow-colour to justify my distinguishing them by the term *chrysophyll* group. They vary somewhat in tint from a little more yellow, to a little more red, than yellow ochre. They are made darker and more orange by oxidisation, and thus are in an unoxidised condition as compared with the colours of the next group. In order to prepare them, the leaves should be boiled in alcohol, and after evaporation to dryness at a gentle heat, the soluble portion re-dissolved in water. I have so far met with at least four different species, distinguished by the spectra which they yield on partial oxidisation. The most satisfactory method is to dissolve some of the colour in a small quantity of water,

dilute this with alcohol, and then to add a little nitrite of potash and hydrochloric acid. In some cases this gives rise to one or more well-marked absorption-bands, and changes the colour from yellow to pink. In others no bands are developed, but the colour is altered from pale-yellow to deep orange-red. On evaporating to dryness, we obtain colours which vary in tint from that of "light red" to those of burnt umber and raw sienna.

The fifth group of colours consists for the most part of various browns, and, therefore, I propose to distinguish it by the term *phaiophyll* group. In most cases they are due to the oxidisation of chrysophyll or other previously existing soluble compounds, as may be proved artificially. There must be, at all events, several colours of this group, but their accurate determination is difficult because they do not give well-defined absorption-bands. On the whole they may be said to be soluble in water and not in bisulphide of carbon, but, in some cases, water alone dissolves them very sparingly, and they are more soluble in dilute alcohol, along with an acid.

When leaves pass into complete decay they turn dark brown, and ultimately become nearly black. This is evidently due to the formation of dark coloured substances allied to humus, but their accurate determination would be very difficult, and I have not yet studied them very much. Though it may be convenient for our present purpose to separate these more or less black colours from the brighter browns of the phaiophyll group, yet I am by no means convinced that there is any actual distinction between them. They are no doubt produced by the decomposition of most varied compounds, both soluble and insoluble; and since it is, perhaps, impossible to obtain these in a pure state, it is difficult to ascertain the exact connection between the various unaltered and altered products.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

March 16th, 1871.

Professor WILLIAMSON, F.R.S., President, in the Chair.

Mr. C. H. Piesse was elected a Fellow.

Mr. C. HAUGHTON GILL read some notes "*On the Examination of Glucose-Containing Sugars.*" Those engaged in the examination of low sugars and molasses have frequently had to complain of obtaining quite unintelligible results. It is well known that the solution of the sugary body is decolourised and clarified by the addition of basic lead acetate before submitting it to optical examination; but Mr. Gill finds that the power of invert sugar to rotate a ray of polarised light is so greatly altered by the presence of this reagent, that the results obtained by the so-called polarisation of syrups containing much invert sugar are worthless when the clarification has been effected in the ordinary way. The alteration of rotatory power of pure invert sugar by basic lead acetate is shown by the following experiments:—

15 c.c. of a solution of invert sugar made up to 50 c.c. by water, observed with a Soliel's saccharometer* in tube of 20, read $-28{\cdot}25$ at 24° C.

15 c.c. of a solution of invert sugar with water and 2 c.c. of saturated solution of basic lead acetate, observed with a Soliel's saccharometer in tube of 20, read $-24{\cdot}7$ at 24° C.

15 c.c. of a solution of basic acetate solution alone, observed with a Soliel's saccharometer in tube of 20, read $+57$ at 25° C.

* The readings of this instrument $\times \frac{25{\cdot}8}{100}$ = angular degrees.

These results have been confirmed by many other observations.

The alteration producing this reversal of rotatory power takes place only on the *levulose* of the liquid; the *dextrose* suffers no change of optical properties.

A solution of pure *dextrose* prepared from invert sugar, and reading 60·3, made up to 2 vols. by strong solution of basic lead acetate, read 30·5.

A solution of nearly pure levulose prepared by Dubrunfaut's method, and reading -44 at 20° C, made up to 2 vols. by solution of basic lead acetate, read $+6$ at 20° C.

The alteration of the rotatory power of levulose is not permanent. On removal of the lead, or on acidifying the liquid, the original rotatory power is restored. The alteration is not due to the alkalinity of the lead solution as regards alkalinity alone, for weak soda or ammonia produce no such change till they begin to decompose and destroy the sugar. It is probable that a soluble lead compound of levulose possessed of dextro-rotatory power is formed.

Now, when a sugar solution containing invert sugar is clarified by basic lead acetate, the invert sugar loses, in part or in whole, its levo-rotatory power, and the first direct reading is too high. When the liquid is acidified and inverted by heat, the original invert sugar has its true levo-rotatory power restored and added to that of the invert sugar proceeding from the cane sugar, thus producing a greater "difference" in the readings than that due to the cane sugar alone, and consequently leading to too high a result.

The remedy for this difficulty is to remove the lead and acidify the liquid before making the first reading. For this purpose Mr. Gill uses a strong solution of sulphuric dioxide, which possesses the advantages of removing the lead and bleaching the liquid at the same time, while it is incapable of inverting cane sugar in the cold even in twenty-four hours. The decolourising effect is so great that even the worst treacles give liquids of a pale straw colour when thus treated, and, moreover, "inversion" can afterwards be performed without any fear of spoiling the colour, whereas by the ordinary method the liquid frequently becomes too red to allow of optical examination.

Another error also arises from the use of the lead-salt as a clarifier for those sugar solutions in which glucose is to be estimated by the use of Fehling's copper solution. The presence of lead here leads to a result much too low, since it also becomes partly reduced, and thereby necessitates the use of a greater volume of the saccharine solution which is called on to reduce lead as well as the known amount of copper. Sulphuric dioxide serves to remove the lead, while excess of the reagent exerts no other action on the copper solution than that of facilitating the subsidence of the cuprous oxide.

As illustrating the extent of the error which may be introduced by the presence of lead, the following experiment, selected from many others, may be taken (solutions of invert sugar of the same strength used in each case):—

Volume required to precipitate cuprous oxide from 10 c.c. of Fehling's liquid—

(1). Free from foreign bodies, 10 c.c.

(2.) Containing 10 per cent of its volume of solution of basic lead acetate, 17 c.c.

Mr. D. HOWARD made some remarks "*On the Boiling-Point of a Mixture of Amylic Alcohol and Water.*" The mixture boils at a lower degree than pure water; thus illustrating the rule announced by a German chemist (Kopp?), according to which a mixture of two liquids boils at a lower temperature than either of the component liquids separately. In the experiment above mentioned, Mr. Howard ascribes it to the circumstance that, probably, the alcohol and the water form, when heated, two separate layers.

Mr. W. H. PERKIN, F.R.S., briefly announced that he had succeeded in obtaining bromacetic acid by digesting and heating bromine with acetic anhydride, subsequent addition of water, and then distillation.

Mr. WARINGTON then made a verbal communication on the "*Commercial Estimation of Sulphocyanides.*" Sulphocyanide of ammonium was frequently present in commercial salts of ammonia, and, being injurious to vegetation, its estimation was often of considerable importance. The reaction of sulphocyanides with ferric salts suggested itself as a possible means of determination; but the depth of colour produced was so influenced by the proportion of iron present, by the proportion of free acid, and, indeed, by the kind and quantity of *all* the salts present in the solution, that, at first sight, a method founded on this reaction seemed hopeless. Many of the commercial ammonia salts, were, however, so nearly constant in composition that it was possible to make use of the reaction referred to. The method adopted was to dissolve in one beaker a known weight of the ammonia salt to be examined, and in a second beaker a quantity of a pure ammonia salt—being the amount of pure salt the sample was supposed to contain. To each beaker was then added equal volumes of ferric chloride and hydrochloric acid. The conditions in the two beakers being now approximately the same (saving the presence of sulphocyanide in the first beaker), a standard solution of sulphocyanide of ammonium was added to the second beaker until the colour in the two beakers appeared equal. The method was, of course, of limited application, but where it could be used possessed the advantage of great speed.

In answer to Dr. Müller, Mr. Warington said that the highest percentage of cyanogen he had observed in the "patent ammonias" was four per cent.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, March 7th, 1871.

THE first paper was on "*The Action of Sulphurous Acid on Phosphates*," by Dr. R. W. GERLAND. (See p. 136.)

"*Further Observations on the Strength of Garden Nails,*" by J. P. JOULE, LL.D., F.R.S. (Will appear in our next).

DR. JOULE exhibited three photographs of the sun taken on the 1st of December, 1858. The images, 0·43 inch diameter, were produced by the achromatic object-glass of a telescope with half-inch stop. Exposure, by means of an apparatus completely detached from the camera, during a small fraction of a second. He had been induced to examine them after seeing the beautiful photograph of the late eclipse by Mr. Brothers. On examining the three images a nebulosity is observed, very similar to that in Mr. Brothers' photograph. In all three, taken at an interval between each of about a minute and a half, the nebulous appearance appears situated on three quarters of the limb, the remainder being quite free. There are also indications of a radial structure, so that he thinks it highly probable that the representations are actually those of the corona.

Since communicating the above, he has carefully examined the two other photographs of the sun which he possesses, and which were taken early in the month of November, 1858. These, one of which must have been exposed at about two hours twenty minutes after the other, present nothing remarkable to the naked eye; but when viewed through a glass of moderate power, a thin crescent-shaped envelope is observed on each, with this remarkable circumstance, viz., that in the two it appears on opposite limbs, suggesting the idea of a semi-revolution in the above interval of time at a velocity not much less than that due to Kepler's law of planetary motion. In one of the photographs there is, under the crescent and apparently on the rim of the sun itself, a narrow band, in breadth about 1-300th of the diameter of the disk, and of at least double the intensity of the sun. This may probably be referred to the actinic action of the chromosphere and the red flames.

"*On Anthraflavic Acid, a Yellow Colouring Matter accompanying Artificial Alizarine,*" by EDWARD SCHUNCK, PH.D., F.R.S., V.P. (In our next).

The PRESIDENT stated that in looking over the Memorandum Book of Mr. Walker, one of the original members of this Society, kindly presented by Mr. Green, he had met with some interesting facts connected with the cotton trade a century ago. At that time the only places from which Manchester received cotton, except from continental ports, were Turkey, the West Indies, Brazil, and Demerara. Several extracts from the book were given.

NOTICES OF BOOKS.

The Sun: Ruler, Fire, Light, and Life of the Planetary System. By RICHARD A. PROCTOR, B.A., F.R.A.S. Longmans, Green, and Co.

THE labours of the Herschels, Schwabe, Carrington, Secchi, De la Rue, Stewart, Huggins, Fraünhofer, and Lockyer in astronomy and spectroscopic chemistry are known to the popular reader but by name only, and works are much wanted which shall render their additions to the knowledge of the grand movements beyond our own globe familiar to the ordinary reader. This familiarity can only be gained by the avoidance of technicality. The general reader seldom has the time, and, perhaps, the inclination to make himself acquainted with technical terms. Such a view Mr. Proctor, it seems, had in composing his work on "The Sun," considered as "Ruler, Fire, and Life of the Planetary System;" but while dispensing with technicalities, or defining those absolutely necessary, he has aimed at pleasing the advanced student as well as the general reader.

The work is an admirable compilation of the particulars of discoveries and of modern theories advanced with regard to the centre of our planetary system. Discarding the imaginative theories of the ancients as being truly unworthy of his space, the author opens his work with a history of the methods used in estimating the distance of the sun from the earth. How the present measurements have been obtained is explained in a most lucid and entertaining chapter. But by far the largest and best portion of the work is devoted to the spectroscopic analysis of the sun's rays; and in this branch Mr. Proctor not only details the labours of others, but suggests valuable improvements in the arrangement of a twice-acting double series of prisms on Browning's automatic system. This and the remainder of the work is carried out very fully; even the method of calculating the velocity of approaching or receding bodies by the differentiation of their spectra is rendered intelligible on the most superficial perusal. Why should not the work have been entirely in this manner, and the cramming of valuable information into foot-notes expunged. The considerations of the transits of 1874 and 1882 are gone into with great expectation of what astronomers by their means look for in the correction of the present distance measurements. Finally, the author presents "reasons for considering that the most important work science has to accomplish is to show how the sun's action can be more fully utilised than it is at present, so that before the earth's stores of force are exhausted (as they must some day be), resources which can never be exhausted—because unceasingly restored—may be rendered available. . . . . Nearly all our motive force is obtained from *stored* sun-force. The machine draws upon the earth's *garnered* stores, while the living worker draws upon the earth's *periodical supplies* of force. In the former case, that is being used up which

cannot be replaced; in the latter, what is consumed will be restored in the ordinary course of nature. We are now utilising (in the products of our coal-fields) what Professor Tyndall calls the sun of the carboniferous epoch: our descendants will have to employ the sun of their own epoch. The heat of the solar rays—mayhap also their light and their actinic energy—must one day be applied to work our machinery." In all, to the scientific student this book cannot convey much, but to the general reader it may be the key to a wider course in the all-engrossing subject of which it treats. A word must be spared to commend the photolithographs with which the matter is interspersed.

CORRESPONDENCE.

PHOSPHATE PROCESS FOR THE UTILISATION OF SEWAGE.

To the Editor of the Chemical News.

SIR,—Mr. Forbes, in his paper on the "Phosphate Process for the Utilisation of Sewage," which appeared in the CHEMICAL NEWS of the 10th inst. (vol. xxiii., p. 112), quotes Dr. A. Voelcker's analysis of the dried sewage deposit prepared by this process, and valued by him at £7 7s. per ton.

Would Dr. Voelcker kindly say whether any, and how much, of the 28·52 per cent of phosphoric acid is combined with the 29·95 per cent of alumina and oxide of iron, and if so, whether the value of the deposit as a manure would not be greatly reduced thereby.—I am, &c.,

SUPERPHOSPHATE.

Royal College of Chemistry, London, W.
March 20, 1871.

THE DEFINITION OF ALLOYS, &c.

To the Editor of the Chemical News.

SIR,—The student who considers the class of bodies known under the name of alloys, amalgams, and such mixtures as acids or alcohol, &c., with water, cannot rest satisfied with the definition that they are chemical compounds, as they do not answer the law of combination in multiple proportions.

That they cannot be called mechanical mixtures, the fact that only the forces at the command of the chemist can separate them into their constituents fully proves. By no merely mechanical means could alcohol be separated from water or the zinc from brass; heat would, in both cases, play the principal part—and this force belongs to the domain of chemistry.

Seeing, then, that these bodies will mix in any proportions, but still, in some respects, retaining the character of chemical compounds, can any objection be raised to their being defined as chemical mixtures? The term seems a fit one to rank between chemical compounds and mechanical mixtures—the place always assigned to the combined bodies in question.

By calling them mixtures the idea is at once discarded of their components being in any definite proportions, and the term chemical fully expresses the intimate nature of the mixture which only chemical forces can separate.

The idea of "chemical mixtures" may not be new, but never having met with the term myself (possibly others of your readers may be in the same case), and if these remarks draw out any opinions throwing light on a still somewhat obscure subject their object will have been fully attained.—I am, &c.,

F. J. R. C.

MISCELLANEOUS.

The Chemical Society.—The Anniversary Meeting of this Society will take place on Thursday next, March 30th, at 8 p.m., when Officers and Council for ensuing year will be elected, and the retiring president, Dr. A. W. Williamson, F.R.S., will deliver the annual address.

Quekett Microscopical Club.—The annual *conversazione* of this Club took place at University College on Friday evening, and was very largely attended, as it usually is. The objects provided by the Club for the entertainment of its guests comprised all the optical novelties of the year, and the Members, as well as the leading opticians, did all in their power to exhibit objects worthy of the position the Club holds in the encouragement of microscopical science. Photography was on this, as at the last annual *soirée*, well represented. A large and interesting series of photographs of Indian temples and scenery was kindly lent by the India Office; also frames of photographs were lent by Mr. J. Van Voorst, Mr. John Foster, Mr. E. Kiddle, and Mr. A. Shapcott. Mr. Apps exhibited at frequent intervals the marvellous electrical effects produced by means of his well-known induction coil. In the midst of so many attractions, it is difficult to single out for especial mention any one feature of interest; but that which seemed possessed at this time of surpassing interest was an exhibition on the screen, by the oxyhydrogen light, of a series of transparent photographs illustrative of the scenery of the late lamentable Franco-Prussian war, contributed by the London Stereoscopic Company, with an explanatory lecture by Mr. James Martin, and which commanded crowded audiences all the evening.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus des Séances de l'Académie des Sciences.

We are now able to resume our abstracts of this weekly periodical, which was regularly printed during the siege of Paris. These numbers contain the following papers relating to chemistry and collateral sciences;—

September 19, 1870.

Salubrity of Soil and of Water.—Professor Chevreul.—This lengthy memoir contains, in aphorismatical style, a series of propositions on the real conditions required for keeping arable soil and all plant-bearing soil, in such a state as to admit of its being the proper medium for plants to grow in, the main point being the possibility of abundant access of oxygen, and of its permanent presence between the solid particles of which the soil is made up; while, as regards water, when considered as a proper medium for the organised beings living therein (plants or animals), the same holds good, and only while containing a large excess of oxygen is that liquid suitable for drinking and other domestic purposes.

September 26, 1870.

The greater part of this number is devoted to a discussion which arose in reference to a paper on the—

Alimentation (Means of Food Supply) to the Inhabitants of an Invested and Besieged Town.—G. Grimaud.—The paper itself, and the ensuing discussion, contains many interesting, and chiefly historical, facts relating to the antiquity of panification and the varieties of food made from grain (oats, barley, rye, rice, wheat) in different countries.

Aurora Borealis of September 24th, 1870.—M. Chapelas.—An account of observations made on this phenomenon as seen at Paris.

October 3, 1870.

New Compounds Resulting from the Union of Cyanic Acid and of Different Cyanic Ethers with the Ethers of Amidated (Amidés) Acids of the Aromatic Series.—A. Cahours and H. Gal.—After referring to the experiments of Dr. P. Griess, and also of the first-named of the joint authors of this paper, made some twelve years ago (see *Ann. de Chimie et de Physique*, 3rd series, vol. lxiii., p. 322), an account is given in this lengthy paper of the mode of preparation, constitution, and properties of very complex substances obtained by the reaction of cyanic acid upon the ethers of the amidated acids, and also of different cyanic ethers with the other ethers just mentioned. As the authors promise, in a subsequent paper, a complete and full account of their labours, we will not give further details now.

Observations on Panification.—M. Mège-Mouriès.

Best Means of Applying Wheaten Flour to the Preparation of Food other than Bread yet Possessed of Nutritive Quality.—L. Aubert.—Both these papers contain valuable hints relating to domestic economy and the making the most of victualling materials.

October 10, 1870.

This number is entirely devoted to the subjects of food supply and preservation of food. An excellent *résumé* of what has been done in this direction.

October 17, 1870.

Difference and Analogy of the à posteriori Experimental Method as Applied to Concrete Sciences and to Moral and Political Sciences.—Prof. Chevreul.—A lengthy lecture by this eminent *savant*.

Process Employed by the Indians of the Territory of the United States for the Preparation (viz., Tanning, Currying, Tawing) of the Hides of Bisons, Deer, and other Animals met with in that Extensive Country.—J. Simonin.—This paper records some curious historical facts bearing upon the primitive, yet effective, methods resorted to by the semi-savages alluded to.

The subjects of aërostatics and air balloons are fully treated in this number.

October 24, 1870.

Total Eclipse of the Sun of December 22nd, 1870.—M. Janssen.—A letter to the President of the Academy.

An Experiment which Confirms the Double Hypothesis set forth by Ampère concerning the Existence of a Closed Electric Current in every Molecule of a Magnetical Substance and in the Earth.—P. Le Cordier.—A mathematico-physical essay.

Relation between Astronomy and Geology.—S. Meunier.

October 31, 1870.

The Use that can be made of Osseine as Food.—E. Fremy.—The author calls osseine the organic matter of bones after the lime salts and other mineral matter contained therein has been removed. The quantity of osseine in fresh bones of slaughtered animals amounts to about 35 per cent of their weight. Osseine should not be confused with gelatine, which latter is a product of the prolonged action of heat and water upon bones, and also differs from osseine as not having an organised structure.

Aurora Borealis of October 24—25, 1870.—Three papers, respectively written by MM. Chapelas, Salicis, and A. Guillemin.

Rapid Method of Tanning Hides and Skins, as carried on in Mexico.—Virlet d'Aoust.—This paper contains an account of a method of tanning goat and other skins by the Indians (Aborigines) of the country alluded to. It appears that they form, with the brains of the animal, and certain vegetable products locally called *cascalote* and *huisaché* (substances containing a large proportion of tannic acid), an emulsion which is forced into the skins by means of squeezing between the hands, or, more rapidly, by stamping with the bare feet. In some parts of Mexico, 4000 or 6000 goats are killed at one time simply for the skin and for boiling down for fat, the blood, flesh, bones, and offal simply being applied as manure.

Common Origin of Serpentine and Chantonnite.—S. Meunier.—The contents of this paper really bear upon the analogy existing between serpentine and a mineral of meteoric origin, called chantonnite, from the name of Chantonnay (France), where a meteorite containing the mineral fell in the year 1812.

This number also contains several papers relating to aërostatics and air balloons, and a curious contribution to historical zoology, on the—

Animals Employed by the Ancient Egyptians for the Purposes of Catching Game.—F. Lenormant.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 2, 1871.

Mathematical Foundation of the Law of Avogadro.—F. Mohr.—This essay and the following, by the same author, on the—

Unequal Conductivity of Gases for Heat—Are, notwithstanding their intrinsic value, not well suited for abstraction.

Sensitiveness for Light of Ferricyanide of Potassium.—H. Vogel.—After briefly referring to the well-known fact that the salt alluded to, as already observed by its discoverer, the late Dr. Gmelin, does not keep well in aqueous solution, the author states that (organic matter apart) the decomposition of the aqueous solution of ferricyanide of potassium is chiefly due to the light, the yellow rays excepted; since, if the solution is kept in yellow-coloured glass bottles, or absolutely in the dark (provided the water be free from organic matter, no decomposition takes place. As a positive proof of this fact, the statement is made that even an exposure of the solution of the salt to direct sunlight for thirty seconds is sufficient to cause the salt to yield with perchloride of iron a blue precipitate, and with salts of uranium the well-known brown colour of ferrocyanide of uranium. The author states that he has tried, with moderately good success, to apply this property of ferricyanide of potasssium for photographic purposes.

Lecture Experiments.—V. Wartha.—Illustrated by a woodcut.

Naphthyl-Purpuric Acid and its Derivatives.—E. von Sommaruga.—The large number, great length, and complexity of the formulæ essential to the proper understanding of this paper, render its abstraction impracticable.

Action of Chloride of Sulphur upon Aniline in the Presence of Sulphide of Carbon.—A. Claus and W. Krall.—This paper contains the account of the continued researches of the authors on the above-named subject. It appears that the reactions first described by them must be somewhat modified. In the first phase, 2 molecules of chloride of sulphur, 4 of aniline, and 1 of sulphide of carbon, become decomposed according to the undermentioned formula, and formation of sulpho-carbanilide, hydrochlorate of aniline, and separation of sulphur—

$$4(C_6H_7N)+2SCl+CS_2=C_{13}H_{12}N_2S+2(C_6H_7N.HCl)+3S.$$

In the second phase of the reaction, the as yet undecomposed chloride of sulphur acts upon the first created sulpho-carbanilide, giving rise to the formation of triphenyl-guanidine and phenylsenfoil according to the following formula:—

$$2(C_{13}H_{12}N_2S)+2SCl=C_{19}H_{17}N_3.HCl+C_7H_5NS+HCl+3S.$$

Researches on the Ether Derivatives of the Polyatomic Alcohols and Acids.—L. Henry.—The sixth portion of this lengthy memoir, treating on the action of pentachloride of phosphorus upon chloral-ethyl-alcoholate.

Isomorphism of Calcareous Spar and Nitrate of Soda.—G. Rose.—This paper contains a few observations on the researches and experiments on this subject by M. L. Meyer, already given in the CHEMICAL NEWS. The eminent *savant* points out that, however correct M. Meyer's observations be, they are not new, since as far back as 1854 (*Comptes Rendus*, vol. xxxviii., p. 105), Dr. Sénarmont made the same experiments with the same result, and the late Prof. Mitscherlich repeated the experiment, not, however, with calcareous spar, but with a piece of dolomite from Traversella. The preparation made by the last-named *savant* is now in the Museum of Minerals at Berlin.

Constance of Colour and Intensity of the Light Emitted by the Clouds in its bearing upon Chromometry.—A. Müller.

By-Product of the Manufacture of Artificial Alizarine.—C. Liebermann.—The author states that, if the action of the potassa, during the fusion along with anthrachinon sulpho-acid, is modified by mixing with the alkali, in different substances, salt and chalk, there is obtained a body containing C, H, and O, entirely different from alizarine, but possessed of the property of being converted into that body by fusion with pure caustic alkalies. This compound is always present to some extent in all artificially-made alizarine, from which it can be separated by baryta water, wherein it dissolves, imparting to it a reddish brown colour. This substance, precipitated from the solution in baryta water by means of HCl, yields, after purifying by solution in glacial acetic acid, a crystalline yellow-coloured matter. According to the researches made by M. Caro, this substance resembles, in its properties, Rochleder's isoalizarine, but analysis proved the substance to be mono-oxyanthrachinon—

$$C_{14}H_7O\overset{O}{\underset{OH}{}}$$

Compounds of Sulphuric Anhydride.—C. Schultz-Sellack.—This lengthy essay contains the following sections:—Combinations of sulphates; combinations of the haloid salts with nitrates; combinations of selenium, tellurium, and iodine.

New Method of Separating Gold and Silver from each other on the Large Scale.—F. Gutzkow.—Reserved for full translation.

Preliminary Notices.—L. Darmstädter.—A brief, and as yet incomplete, account of some experiments on the action of nitric acid upon bichromate of potassa.

Hydrate of Sulphide of Carbon.—M. Ballo.—The main gist of this lengthy paper is, that the statement made of the existence of solidified sulphide of carbon (frozen sulphide) is not correct, and is explained by the existence of a hydrate of the body alluded to, CS_2+H_2O containing about 19·14 per cent of water.

Preliminary Notice on the Action of Chloride of Zinc, Nitrous Acid, Bleaching Powder, and Hydrochloric Acid upon Morphia, and the Action of Chloride of Zinc upon Papaverine.—E. L. Mayer.

Journal für Praktische Chemie, No. 2, 1871.

Constitution of Ultramarine.—W. Stein.—This essay treats on the mode of combination in which sulphur is present in artificially

made ultramarine. While admitting the difficulties of fully elucidating this point, the author states that his aim is to prove that blue ultramarine contains sulphurous, not hyposulphurous acid, which former, however, is not an essential constituent; and further, that ultramarine contains only sulphuret of aluminium, there being no sulphuret of sodium at all. To give the experimental proof of these statements, the essay treats at length the following points:—Testing for hyposulphurous and sulphurous acids; testing for sulphurets; existence of sulphuret of aluminium in two different modifications. The conclusions drawn by the author from his experiments are—Ultramarine consists mainly of a white mass, through which and with which black sulphuret of aluminium is most intimately and molecularly incorporated; the blue colour of ultramarine is, therefore, not due to its chemical composition, but to the optical relation of its component substances. The essay winds up with some observations on white and green ultramarine; the latter contains less soda than the blue-coloured pigment, and that, again, less soda than the white pigment. The quantity of sulphur contained in blue-coloured ultramarine is less than that contained in green-coloured ultramarine.

Chinon-Like Derivatives from Thymol.—E. Carstanjen.—This exhaustive memoir contains the following sections:—On thymoïle; action of bromine on thymochinon; mono-bromo-thymo-chinon, $C_{10}H_{11}Br(O_2'')$; oxythymo-chinon, $C_{10}H_{11}(HO)(O_2'')$; constitution of thymol and of its chinon-like derivatives; diamido-thymol.

Contribution to the History of the Knowledge of the Constitution of Diglycolic Acid and of the Di- and Tri-Glycolamid Acids.—W. Heintz.—This paper and the following—

Observations on M. Heintz's Foregoing Essay—Dr. H. Kolbe.—Are, however valuable, not well suited for abstraction.

New Method of Converting the Fatty Acids into the therewith Corresponding Alcohols.—A. Saytzeff.—This paper is divided into the following sections:—Introduction, treating on the isomerism and constitution of alcohols, more especially butylic alcohols; conversion of chloracetyl into ethylic alcohol; conversion of chlor-propionyl into normal propylic alcohol; conversion of chlor-butyl into normal butylic alcohol.

Behaviour of Normal Iodide of Butyl towards Alcoholic Caustic Potassa Solution.—A. Saytzeff.—The first, and as yet incomplete, portion of an essay on this subject.

Polytechnisches Journal von Dingler, first number for February, 1871.

Simple and Ready Method for Determining the Magnifying Power and the Range of Vision of a Spy-Glass and Telescope.—Dr. A. von Waltenhofen.—A lengthy mathematico-optical essay illustrated with engravings.

Precipitation of Small Quantities of Phosphoric Acid by Molybdate of Ammonia, and some Remarks on the Yellow-Coloured Silico-Molybdic Acid Precipitate.—Dr. E. Richters.—Reserved for full translation.

Application of some Fluorine Compounds for the Purposes of Rendering Glass Opaque, especially for Photographic Use.—E. Siegwart.—This paper contains a review of all that has been hitherto done as regards the application of hydrofluoric acid and other fluorine compounds to the technology of glass.

Materials and Facts for Judging on the Quality of the Air in Public Buildings.—Dr. H. Dorner.—This essay bears more particularly upon the condition and quality of the air in some public buildings at Hamburg.

Caloric Capacity of the Air.—F. Ritter von Schwind.—An algebraico-physical essay.

Objective Treatise of the Stroboscopic Disc.—Dr. E. Zizmann.—Illustrated with woodcuts.

Black-Coloured Shining Pigment on so-called Sugar-Paper.—Dr. Kielmeyer.—After referring to a rather clumsy method, now in use in Austria, of making the paper, or rather of painting it on one side only. The author gives a receipt for performing the operation by means of the continuous paper-making machinery.

So-called Dry Purification and Cleaning of Wearing Apparel.—Dr. M. Reimann.—Illustrated with engravings and woodcuts.

Application of Soda and Alkali Works' Refuse for the Purpose of Making the Embankments and Permanent Ways of Railways.—M. Schaffner.—The author calls attention to the fact that the refuse alluded to, and remaining after having been desulphurised, consisting mainly of carbonate and sulphate of lime and some sulphite of lime, is an extremely useful material to be employed instead of sand for the above-named purpose; also on account of the preservative property of the constituents of the material for the wooden sleepers.

Preparation of a Fine Blue-Coloured Ink.—Dr. Dingler.—Take, of yellow prussiate of potassa, 10 parts, dissolve in 160 parts of pure distilled water; gradually, and while stirring, add to that solution a mixture of five parts of a solution of perchloride of iron (sp. gr. 1·480) and 160 parts of water. The ensuing precipitate is collected on a filter, and washed with distilled water until the wash-water begins to assume a blue colour, after which the precipitate, which has then, by the bye, become completely soluble in distilled water, is dissolved in 400 parts of that water.

NOTES AND QUERIES.

Percentage of Anthracen.—Can any reader of your valuable journal inform me of the commercial mode for testing the percentage of anthracen, and oblige.—ANTHRACEN.

Determination of Suphur in Cast-Iron, &c.—(Reply to S. G. G).—The solutions in the flask were repeatedly tested for sulphuric acid, and none ever found. The insoluble residues contain mere traces of sulphur which I believe to exist as sulphate.—A. H. ELLIOTT.

Obtaining Silver from Sea-Water.—Is anything known of I. H. Steele's process for this (16, Windmill Street, Gravesend)? Does it succeed? What is its nature, requiring some instrument capable of being used by any seaman? Each capable of yielding some hundreds of pounds a year.—K.

Plattner's Charcoal Blocks, &c.—Will anybody in London undertake to make Plattner's charcoal blocks, small clay roasting capsules &c., at a moderate price? Especially the ordinary qualitative blocks. Good charcoal is almost non-existent in England. Mr. Bates, of 20, Litchfield Street sells it. I have just bought up all worth having.—PER MARE PER TERRAM.

Tattooed Marks.—Let "Scotia" consult Tardieu's paper in the *Am. d'Hyg. Publique*, 1855, p. 171, &c. In a successful attempt at removal the mark was first well rubbed with a salve of pure acetic acid and lard, then with a solution of potash, and finally with hydrochloric acid. Further particulars are contained in the paper, and in the English translation of Casper's "Handbook of Forensic Medicine," vol. i., p. 108.—T. STEVENSON.

Writing Ink.—(Reply to H. Pitt).—The greenish tinge is not due to indigo. We quote the following receipts from Wagners's work on "Technology":—Take of decoction of logwood (one part of wood to eight of water) 1000 parts, add thereto one part of neutral (lemon-yellow) chromate of potassa, and a few grains of mercuric chloride (corrosive sublimate); This ink writes greenish, but becomes very black. Take of nutgalls 42 parts, madder three parts, and exhaust with water, so as to obtain, after filtration, 120 parts; next add of sulphate of indigo 1·2 parts, protosulphate of iron 5·2 parts, and 2 parts of the commercial solution of pyrolignite of iron. For copying ink, make either of these two more concentrated, and add some gum and sugar.—CHEMICUS.

MEETINGS FOR THE WEEK.

MONDAY, 27th.—Medical, 8.
—— London Institution, 4. Mr. R. A. Proctor, F.R.A.S. "On Astronomy."
—— Geographical, 8.20.
TUESDAY, 28th.—Royal Institution, 3. Dr. Foster, "On Nutrition of Animals."
—— Civil Engineers, 8.
—— Ethnological, 8.
WEDNESDAY, 29th.—Society of Arts, 8.
THURSDAY, 30th.—Royal, 8.30.
—— Royal Institution, 3. Dr. Odling, "On Davy's Discoveries."
—— London Institution, 7.30. Professor Bentley, "On Economic Botany."
—— Chemical, 8. Anniversary.
FRIDAY, 31st.—Royal Institution, 9. Professor Max Müller, on "Solar Myths."
SATURDAY, April 1st.—Royal Institution, 3. Mr. O'Neil, "On the Spirit of the Age."

TO CORRESPONDENTS.

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E. Kernan.—The publication of *Les Mondes* is resumed; we have received numbers for March 2nd and 9th.

E. W. Parnell.—Thanks for your communication; it shall appear in an early number.

R. Carter Moffat, Ph.D.—Received.

G. B. Buckton.—Received.

Manning Prentice, jun.—Your request shall receive attention.

C. S. Overy, J. and E. Sturge, G. Rogers.—Our publisher will communicate with these correspondents shortly.

R. Warington.—Thanks for your enclosure.

S. Wilkinson.—Bunsen's "Gasometry" will answer your purpose.

T. Chartres White.—Thanks for the Report.

G. Stock.—We will write by post.

J. H. C.—You will probably obtain cryolite from some of the manufacturing chemists in the Lancashire district, Newcastle, or Glasgow

G. A. Keyworth.—Next week.

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IV. The Great Pyramid of Egypt, from a Modern Scientific Point of View. By C. PIAZZI SMYTH, F.R.S., Astronomer Royal for Scotland.
V. Steam Boiler Legislation. By Sir WILLIAM FAIRBAIRN, Bart., LL.D., F.R.S. With Page Woodcut.
VI. The Eclipse of Last December, with special reference to the Interpretation of the Solar Corona. By RICHARD A. PROCTOR, B.A. Cambridge. With Page Plate and Two Woodcuts.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 592.

FURTHER OBSERVATIONS ON THE STRENGTH OF GARDEN NAILS.*

By J. P. JOULE, LL.D., F.R.S., V.P.

THE author thought it desirable to ascertain how far hardness had to do with the strength and elasticity of these small specimens of cast-iron. For this purpose he plunged some of them at a heat near the melting point into water, then selecting those which had been hardened sufficiently to resist the action of the file. Others he cooled slowly from a bright red heat. The experiments were conducted in the manner described in the last number of the proceedings.

	No. of Experiment.	Length of Nail between Supports.	Breadth of Nail at Fracture.	Depth of Nail at Fracture.	Deflection.	Breaking Weight. lbs.
Hard Nails.	1	1·00	0·110	0·122	0·0067	129
	2	1·04	0·120	0·120	0·0037	84
	3	1·00	0·120	0·122	0·0028	81
	4	1·02	0·143	0·102	0·0077	129
	5	1·10	0·138	0·130	0·0071	203
Average		1·032	0·1262	0·1192	0·0056	125·2
Soft Nails.	6	1·00	0·112	0·117	0·0088	141
	7	1·05	0·139	0·114	0·0087	150
	8	1·02	0·130	0·138	0·0051	176
	9	1·04	0·117	0·090	0·0101	101
	10	1·04	0·121	0·108	0·0073	113
Average		1·03	0·1238	0·1134	0·0080	136·2

Reducing to a length of three feet and one inch square section, and making a deduction of one-sixth from the deflections, on account of the taper of the nails, the above results, along with those in the last number of proceedings, become—

	Breaking Weight.	Deflection.
Nails in original state	2673	0·922
Hardened ditto	2002	0·677
Softened ditto	2448	0·924

ON THE ESTIMATION OF PHOSPHORIC ACID.

By E. W. PARNELL.

IN making accurate determinations of phosphoric acid, by precipitation as magnesium ammonium phosphate, an allowance is generally made for the solubility of the precipitate in the ammoniacal liquid, one milligramme for every 54 c.c. of the filtrate and washings being added to its weight after ignition. Some results that I have recently obtained in analyses, and subsequent experiments, have led me to conclude that this correction is unnecessary.

With a view of ascertaining the accuracy of the molybdic acid method of estimating phosphoric acid, I weighed out two portions of powdered crystallised sodium phosphate; the phosphoric acid in one I determined by direct precipitation, as magnesium ammonium phosphate. To the other I added a solution of molybdic acid in nitric acid, and proceeded with the estimation precisely as recommended by Fresenius, in both cases making the usual correction for the solubility of the precipitate. The first determination gave phosphoric acid 24·55 per cent; the molybdic acid method 24·98 per cent. The precipitate in the latter case proved to be quite pure, free from molybdenum and excess of magnesia. As the proportion of filtrate to precipitate was much larger in the latter case than in the former, too large an addition for the filtrate would cause the molybdic acid method to show the higher result; I therefore proceeded to ascertain by experiment the extent of correction necessary. A filtrate, measuring about 500 c.c., was evaporated to dryness, ignited to expel ammoniacal salts, the residue dissolved in a small quantity of hydrochloric acid, and the liquid neutralised with ammonia. The volume, after addition of ammonia, measured about 10 c.c. I should, therefore, obtain a precipitate that 490 c.c. had held as a saturated solution. No precipitate appeared even after several days; this would indicate that no correction was necessary,—making no allowance.

The first estimation shows 24·30 per cent phosphoric acid.
The molybdic acid method, 24·26 " " "
results which agree satisfactorily.

The solubility of the precipitate in a solution of chloride of ammonium and ammonia is beyond question; the only conclusion, therefore, to be drawn was that it was insoluble in presence of excess of magnesia. This proves to be the case. I prepared a saturated ammoniacal solution of the salt: to a portion I added an ammoniacal solution of magnesia; this produced an immediate precipitate of the double salt. To another portion I added a solution of sodium phosphate; this singularly also produced a precipitate. From this, in estimating magnesia as the double phosphate, when an excess of phosphoric acid is present in the liquid, the usual correction of one milligramme for every 54 c.c. is too high. From weighed quantities of pure magnesia I have obtained the theoretical quantity of magnesium phosphate without any correction for the filtrate.

Attention was called a few weeks since, in the CHEMICAL NEWS, to the difficulty of obtaining a pure magnesium ammonium phosphate by precipitating a solution of phosphoric acid with a solution of magnesia, an excess of the latter base being invariably carried down. The remedy suggested was that the precipitate should always be redissolved, and re-precipitated with ammonia. I find that this excess is more liable to fall when the solutions are concentrated; with solutions not strong enough to produce an immediate precipitate, but from which the double salt separates out after a few minutes' standing, a perfectly pure precipitate may be obtained. I have sometimes found the ignited precipitate to contain an excess of magnesia to the extent of eight per cent. In such cases, resolution in hydrochloric acid and re-precipitation with ammonia failed to give a pure precipitate, the excess of magnesia being merely reduced to about four per cent. In order to ensure the purity of the precipitate. I now raise the two ammoniacal solutions to the boiling point; on mixing them, and stirring, a bright crystalline precipitate appears, which, so far, has never failed to be perfectly pure. This plan is especially advisable in presence of citrate of ammonia; from cold solutions, citric acid, with probably magnesia, is almost always carried down with the precipitate, and after long ignition, the latter will be sometimes found to enclose a considerable quantity of carbon.

ON THE REACTIONS OF VARIOUS OILS WITH H_2SO_4.

By G. P. CLARKE.

HAVING found that the tables of these reactions which are given in various text-books differ considerably, and that the account of each particular reaction is very incomplete, I made a very careful series of experiments on the

* Read before the Manchester Literary and Philosophical Society, March 7th, 1871.

subject. The specific gravity of the oils, which were, as far as possible, perfectly pure, was taken by weighing, at a temperature of 15° C. I found that the addition of H_2SO_4 brought out the characteristic odour of the oil better than by heating it. The proportion of oil and acid was 25 drops to 1 drop. Subjoined is the result:—

Oleic Acid (commercial) from Distilled Palm Oil.—Instantly forms a brown-red spot, with a dark outer ring; small brown particles appear, and dart about on surface of oil. On being stirred, becomes uniformly chocolate colour, which gradually grows streaky and deposits a white film. Sp. gr., 902·346. Solidifies at 4° C.

Oleic Acid (commercial) from Distilled Cotton Seed Grease.—Instantly forms a deep red spot, with dark concentric rings. On being stirred, becomes purple-red, does not become streaky, and keeps the same colour for a considerable time. Sp. gr., 915·924. Solidifies at 5° C.

Bleached Neutral Olein from Palm Oil.—Spot at first greenish-yellow, with a slight nucleus; a number of cells appear, these converge, and form a large brown nucleus, which revolves rapidly, and throws off brown fibres which form concentric rings. On being stirred, it separates into brown patches and transparent streaks, giving the oil a marbled appearance. Sp. gr., 914·381. Solidifies at 10° C.

Neutral Olein from Tallow.—Light yellow oval spot; nucleus forming a straight line, having a brush at each end; this throws off pink rays, till in a short time the whole of the oil is coloured light pink. On being stirred, the oil becomes a dark orange-colour. Sp. gr., 917·159. Solidifies at 5° C.

Lard Oil.—Spot greenish yellow, non-nucleated; a dark brown ring skirts the edge of the pool of oil, throwing off brown streaks towards the centre; the top of the oil then becomes covered with a red-brown crust. On being stirred, the oil becomes full of brown specks, which revolve rapidly and evolve bubbles of gas. Sp. gr., 920·245.

Ground Nut Oil.—Yellow spot, which moves from side to side, and throws off an orange crust on the surface of the oil. On being stirred, the oil becomes streaky brown, and gives off gas. Sp. gr., 921·788. Solidifies at −2° C.

East India Castor Oil.—Faint yellow spot, with several transparent nuclei. On being stirred, the oil becomes almost colourless, and gives off bubbles of gas. Sp. gr., 963·757.

Doddee Seed Oil.—Oval spot, with brown-red concentric rings, each increasing in darkness as it nears the centre; has a black nucleus which revolves rapidly. On being stirred, becomes a brown-black mass which rapidly thickens. Sp. gr., 932·897.

Sperm Oil.—Brown spot, with rays from a black nucleus to the circumference, the spot surrounded by a very faint outer yellow ring. On being stirred, the oil became light purple, then dark purple, and finally brown-red. Sp. gr., 885·682.

Pale Seal Oil.—Orange spot, which revolves rapidly, and sends off purple streaks forming a large ring. On being stirred, becomes a bright red, which quickly darkens, and becomes full of dark spots. Sp. gr., 926·108.

Gallipoli (Olive) Oil.—Spot at first colourless, then becomes faint orange, and sends off grey crust on to surface of oil. On being stirred, becomes first green, then grey, and becomes a streaky mass with a dark nucleus. Sp. gr., 919·628.

Niger Oil.—Spot at first colourless, then slowly darkens, and dark rings pass to the centre from the circumference; these form a dark nucleus, which elongates itself, and becomes a straight line, throwing off a grey crust on to surface of oil. On being stirred, becomes first olive, then red-brown, and finally dark green. Sp. gr., 928·577.

Rosin Oil.—A small blood-red spot, with well-defined edge, which remains perfectly stationary, and does not expand. On being stirred, becomes a fine orange red colour, afrer standing some time blood-red patches appear. Sp. gr., 990·606.

Best Olive Oil.—Spot at first colourless, then becomes yellowish-green. On being stirred, becomes olive-green. Sp. gr., 917·776.

Refined Rape-Seed Oil.—Bright yellow spot, with red rings; spot gradually grows dark brown, and throws off a brown crust on to oil. On being stirred, forms a black-brown mass. Sp. gr., 919·011.

Poppy Oil.—Motionless mustard-yellow spot, with orange rings. On being stirred, becomes buff, and finally red-brown, and gives off gas. Sp. gr., 926·232.

Mustard Oil.—Dark yellow spot, with fibrous orange streaks; nucleus revolves rapidly. On being stirred, becomes reddish brown. Sp. gr., 918·270.

Cod Liver Oil.—Orange spot, with dark red nucleus, sending off a purple crust on to oil, which soon becomes brown. On being stirred, becomes bluish-purple, then red-purple, and lastly, red brown, with a streaky appearance. Sg. gr., 924·565.

Almond Oil.—Spot at first colourless, then green yellow with an orange nucleus. On being stirred, becomes olive and then brown, with a marbled appearance, gives off large quantity of gas. Sp. gr., 919·010.

Each experiment lasted ten minutes, and the sample being tested, was carefully observed with a large magnifying glass during the whole time. I have in hand some experiments on mixtures which I hope to be shortly able to lay before you.

ON THE

CHANGE EXPERIENCED BY METALLIC IRON AND BY IRON OXIDES WHICH HAVE SERVED TO DISSOCIATE CO.*

By I. LOWTHIAN BELL.

(Continued from p. 136).

Expt. 338.—A mixture of 100 vols. of CO and 9 vols. of CO_2 was passed over spongy iron for 2½ hours; at the end of this time its composition was—Fe, 91·42; C, 0·33; O, 8·25 = 100.

Before leaving the subject of carbon deposition on pure spongy iron, it may be interesting to quote the results of a simultaneous exposure of this substance, and oxides of iron differently prepared in the lead bath arrangement, during a period of nine hours, to a temperature of melting zinc:—

Substance employed.	C. deposited per 100 Fe present.
Expt. 339.—Pumice-stone, saturated with Fe_2O_3 from $FeSO_4$	808
,, 340.—Precipitated Fe_2O_3 anhyd.	207
,, 341.—Fe_2O_3 from $FeSO_4$	206
,, 342.—Pure, spongy iron.	158

So that these figures do not indicate that iron, in its metallic state, possesses any advantage over its oxide in separating C from CO.

To compare the effect produced by heated CO on iron of a porous texture with that when solid iron was used:—

Expt. 343.—Thirty feet of fine iron wire (one foot weighing 0·59 grain) was well cleaned with sand paper, cut into short lengths, and introduced in a half-pound flask provided with a thermometer, and also with outlet and inlet tubes, A rapid stream of CO was driven through the apparatus for one hour; the gas being previously thoroughly purified, by passing through 2KHO bottles, $AgNO_3$, and KHO bulbs. It showed no turbidity in being passed through lime water for twenty minutes. Heat was now applied by the air bath, and observations made of the issuing gas on lime water.

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* From the "Chemical Phenomena of Iron Smelting."

Time. hr. min.	Temperature. °C.	°F.	Effect on lime water.
1 0	18 rising to 204	(65 to 400)	*nil.*
0 30	204 ,, 227	(400 ,, 440)	do.
0 25	227 ,, 243	(440 ,, 470)	do.
0 45	243 ,, 271	(470 ,, 520)	do.
0 30	271 ,, 282	(520 ,, 540)	No opalescence.

So far, then, as the lime water indicated, there was no action; but next day, on examining the wire, almost the whole was turned blue, and the remainder, straw colour; and when strong HCl was poured upon it and almost immediately decanted off, the solution gave an intense blue with ferrocyanide of potassium, showing a film of oxide of iron, higher than FeO, had been formed, and proving that a portion of the CO had been decomposed, but in too minute quantity to produce a perceptible effect on lime water.

Expt. 344.—The same wire was next exposed to a higher temperature, viz., bright red, but previously to turning on the CO, H was passed over the wire, in a heated state, to reduce any rust which might be adhering to its surface.

The CO was obtained from sulphuric acid and ferrocyanide, passed through a bottle containing a solution of potash, then, through two tubes containing $AgNO_3$; three tubes, containing dry KaO; and one, containing pumice-stone, saturated with HSO_4. Air was expelled by passing this gas through the apparatus for 1¾ hours; heat was then applied and maintained at a bright red for four hours, the current of CO being continued until the whole was cooled.

The wire was blue on the surface, and the 40 grains used had increased 0·12 grain.

The potash bulbs behind the apparatus had increased in weight 0·27 grain.

According to the action of $2CO = C + CO_2$, 0·27 grain of carbolic acid collected in the potash bulbs ought to represent 0·07 grain of deposited carbon, but the gain in weight being 0·12 grain, the difference of a portion of it must be due to oxidation of the iron, indications of which were manifested by the change of colour in the wire itself.

The wire, which had served in the experiment, was then dissolved in one portion of HCl, and a similar quantity, which had been exposed to the hydrogen current alone, was similarly treated by another portion of HCl. The solution from the first had floating about in it some whitish flocculent particles, and a few small black flakes. In the second, an extremely minute trace of the whitish matter appeared in two days, but no appearance of the dark coloured flakes could be perceived.

This experiment, therefore, justifies the belief that compact iron slowly acts on CO by resolving it into C and CO_2, while the metal itself acquires a minute trace of oxygen.

This view of the effect of iron, in its dense form, on oxide of carbon is further confirmed by the appearance of the inside of the iron vessel which served to contain the specimens exposed to the action of CO in the lead bath. It was noticed, after this apparatus had been in use a few times, the interior was coated uniformly with an impalpably fine black dust—no doubt C, precipitated from the CO, to which the surface had been exposed.

Expt. 345.—The faculty of metallic iron, particularly in a state of fine division, to precipitate carbon from oxide of carbon, being now proved beyond a doubt, steps were next taken to ascertain its effect upon the gas, at lower temperatures.

All the precautions, previously described, to ensure, as far as practicable, the absolute purity of the CO were observed, and, as in one or two cases, the $AgNO_3$ was blackened by the passage of the gas, to prevent any CO_2, which might thereby have been generated, the CO, before being admitted to the reduced oxide, was freed from such possible contamination by being passed through two tubes, containing KHO in its solid form, which also retained any moisture, avoiding thus the introduction of any impurity by the use of SO_4H_2 and pumice-stone. The gas, thus purified, was passed through the apparatus for two hours, before the Liebig's tube, which contained spongy iron, was attached, or heating commenced.

The gas was tested, previous to immersing the tube in the air bath with the following results:—

5·75 volumes exploded with O gave

	Contraction.	CO_2.
Theoretical for pure CO	2·900 =	5·80
	2·875 =	5·75

The spongy iron was ascertained to contain 99·9 per cent of Fe, by permanganate, harpsichord wire being 99·5. After it had been exposed for five and a half hours, at a temperature of 238° to 243° C. (460° to 470° F.), the iron had a black, apparently carbonaceous layer, on the surface, and yielded a distinct quantity of CO_2, on burning in a stream of oxygen. The metal, moreover, had increased in weight 0·3 per cent.

Expt. 346.—In order to observe the rate at which CO_2 was given off by pure spongy iron acting on CO, the KHO bulbs were weighed at various intervals, but, of course, the weights so obtained do not represent the CO_2 generated by the carbon deposition alone, but also that due to the oxidation of the $Fe_xCO + Fe = FeO_x + xC_{O_2}$.

Thermometer range.	Time of exposure.	Increase of KHO bulbs.
227° to 254° C. (452° to 470° F.)	1 hour	0·011 grm.
232° ,, 240° ,, (450° ,, 472° ,,)	¾ ,,	0·009 ,,
232° ,, 240° ,, (450° ,, 472° ,,)	1¾ ,,	0·034 ,,
232° ,, 221° ,, (450° ,, 420° ,,)	1¼ ,,	0·017 ,,
227° ,, 238° ,, (452° ,, 460° ,,)	1 ,,	0·008 ,,
243° ,, 238° ,, (469° ,, 460° ,,)	1¼ ,,	0·023 ,,

The spongy iron had increased in weight, and contained traces of carbon—0·009 per cent.

The behaviour of spongy iron when enveloped in the earthy constituents found in an ore, is similar in every respect to the metal when presented in its isolated form to the action of CO, as described in the experiments immediately preceding, only the diluted condition in which the Fe is found, for example in calcined Cleveland ore reduced by H, interferes, as one might expect, with the rapidity of the action.

A quantity of this ore was completely reduced by H, when it was found to consist of:—

Fe	50·58
Earthy matters	49·42
	100·00

(To be continued.)

ACCOUNT OF A FEW

EXPERIMENTS MADE FOR THE PURPOSE OF PRESERVING RAW MEAT.

By Dr. BAUDET.

SINCE I had obtained, by a lengthy practice, some considerable experience as regards the antiseptic and preservative properties of a substance which I term *spyrol* (carbolic acid), for being applied to the tanning, tawing, and currying operations, I felt induced to try some experiments as regards the use of that body for the preservation of meat.

First process: *By immersion in phenic water at from 5-10,000ths to 1-1000th.*—On the 18th of October last year, I took four wide-mouthed stoppered bottles, and placed in each 250 grms. of raw horseflesh, slightly moistened with phenicated water in the following proportions:—No. 1, solution at 4-1000; No. 2, solution at 3-1000; No. 3, solution at 2-1000; No. 4, solution at 1-1000. To the contents of every bottle I added a few small pieces of well-burnt charcoal, with the view to absorb any gaseous matter which might be evolved from the meat; after having

hermetically closed the bottles, I have kept these for thirteen weeks in a room constantly heated at from 15° to 20°. On inspecting the bottles after the lapse of time just mentioned, I found that the liquid which covers the meat had in all bottles become slightly rose-red coloured. The state of the meat, on examining it, was found as follows:—No. 1. The meat had become somewhat blackish-coloured, but was not spoiled at all. No. 2. Meat very well preserved, colour light rose-red. No. 3. Meat perfectly well kept, with the natural colour of fresh meat. No. 4. Meat has quite well kept; its colour has greatly improved considering that raw horse-flesh is naturally deep-coloured. A few days after, having inspected and noted down, as described, the contents of each bottle, I have taken a portion of the meat of No. 3 bottle, and, without having it washed or drained, have fried it, and dressed as a beef-steak; on partaking of it, in company with several other parties, we found the meat excellent, having only acquired a slight taste similar to that of cured ham and bacon, but by no means disagreeable. I have kept at the same temperature as indicated above, and under the same conditions, the meat in the bottles, well-closed, and have not observed, up to the middle of February last, any other change in the meat than an external drying and shrivelling up, and deeper colour, but internally the natural colour remains. From the foregoing experiments, I conclude that phenicated water, in the proportion of from 1-100oth to even 5-10,000th, might be applied to keep raw meat fresh and sweet, without imparting to it either any perceptible smell or taste, provided the meat be kept in well-closed vessels, be they casks, tinned iron canisters, or other vessels.

Second process: *By means of vegetable charcoal coarsely broken up, and saturated with phenicated water at from 5-10,000ths to 1-1000ths.*—This process is applied as follows:—I cover the meat with a thin woven fabric, in order to avoid its direct contact with the charcoal, which might penetrate into the fibre of the meat, which is placed next into barrels, care being taken to place therein first a layer of the phenicated charcoal, then a layer of meat, and so on, alternately, until the barrel is quite filled, and all interstices properly taken up by the charcoal. As regards the importation of raw meat, preserved by this method, from South America, I would suggest that the meat, first covered with any thinly-woven fabric, be placed in bags made of raw caoutchouc, very abundantly obtainable in the country alluded to; so that the importation of raw meat and the importation of caoutchouc might go, as it were, hand in hand. The mode of filling in alternate layers of phenicated charcoal and meat would, of course, remain the same; and there would be no difficulty of hermetically sealing up bags made of caoutchouc, either by soldering the seams together, or by placing a cap of caoutchouc over the mouth of the bag, and soldering the cap on hermetically.—*Moniteur Scientifique.*

ON THE VARIOUS TINTS OF AUTUMNAL FOLIAGE.

By H. C. SORBY, F.R.S., &c.

(Concluded from p. 139).

HAVING given a general account of the various colouring matters met with in foliage, I will now proceed to show how they serve to give rise to the almost endless variety of autumnal tints. These are usually due to varying mixtures of colours belonging to two or more groups. It is very doubtful if any leaves are coloured by one single substance, and generally they contain not only colours belonging to several groups, but even more than one of the same group.

Unfaded green leaves are coloured mainly by chlorophyll, but the tint is very much modified by xanthophyll, and by colours of the chrysophyll group. The presence of these, in varying relative and absolute amount, explains in a most satisfactory manner all the various brighter and darker greens met with in different leaves in different conditions. It is doubtful if chlorophyll has ever been seen free from xanthophyll. On heating green leaves with alcohol, a bright green solution is obtained. On agitating with bisulphide of carbon, this sinks to the bottom with the greater part of the chlorophyll and some xanthophyll in solution, whilst the alcohol retains most of the xanthophyll and some chlorophyll. After agitating this with a little fresh bisulphide, evaporating to dryness, and dissolving out the chrysophyll by water, when dry, the impure xanthophyll may be dissolved in bisulphide of carbon. The solution of chlorophyll in the bisulphide first obtained may be somewhat purified by agitating with fresh alcohol, but even then the spectrum clearly shows the absorption-bands due to xanthophyll. Still, on comparing the two different products, we can see at once that an approximate separation has been effected, and that for an equal amount of chlorophyll one contains six or eight times as much xanthophyll. This is a mere green-yellow, and the other a bright green; but, since it must be made considerably brighter by the xanthophyll, pure chlorophyll is no doubt of a darker and bluer green colour. The tint of many green leaves is also much modified by various colours of the erythrophyll group, which give rise to more or less green browns, and, in some cases, almost to black; for the green chlorophyll absorbs the blue and red rays, and the erythrophyll the green, so that all light is extinguished. If the erythrophyll preponderates over the chlorophyll, we have a red or even purple green, as in the case of the copper and purple beech; and thus, independent of any change, there is a considerable variation in the tints of normal growing leaves. It is, however, in autumn, when the chlorophyll has disappeared, that the brighter and more definite colours are produced. The amount of xanthophyll which is found in green leaves is so considerable, that probably the yellow colour of faded leaves is quite as much, or even more, due to that which previously existed than to any specially developed in the change, and the alteration which may be said to consist chiefly in the disappearance of the chlorophyll. The result of this is that a deep green is changed into a bright yellow, and the general change in the spectrum is that there is no longer any absorption at the red end. Probably, however, few yellow leaves are coloured merely by xanthophyll, and the tint of many depends quite as much on the chrysophyll, and is also very much modified by colours of the erythrophyll and phaiophyll groups.

As I have already named, many leaves contain colour of the erythrophyll group, even when young and healthy, but the production of a red colour is more common in autumn, when their vitality is diminished. In some cases it takes place whilst the chlorophyll is unchanged, or only partially altered into the browner modification, and then its production merely gives rise to a dark brown which does not attract the eye. The deep brown colour of heath in autumn is an example of this, and on careful examination it may be seen that the brown shade is almost entirely confined to the side of the plant which is exposed to strong light. The red colouring matter is so disguised by the green chlorophyll that one would scarcely expect to extract, by the method already described, a colour quite equal in beauty to carmine, and of almost exactly the same tint. Very many other illustrations might be given of the same general fact, but the colour does not attract attention until the chlorophyll fades, and then the mixture of the previously existing red with a more or less pure yellow gives rise to scarlet. This may be seen to great advantage in the leaves of the common bramble and many other plants. It may then be asked why we never see a fine scarlet in the case of heath or purple beech. The explanation seems to be that in them the red colour is not the same as in the case of the numerous plants which turn scarlet, and is so much more easily decomposed that

it entirely fades before the chlorophyll is altered. The spectrum method indicates that the colour of these two plants is the same, but differs from that red colour which occurs in most of those turning to a fine scarlet, as, for example, in the leaves of the bilberry, bramble, hawthorn, Berberis, cherry, apple, and guelder-rose. In other plants the red colour is not specially developed, whilst the chlorophyll is unchanged, but is produced at the time of that change, as if in some way dependent on the same cause. I have especially studied this point in the case of the leaves of the common sorrel, and find that the production of the red colour depends in some way on exposure to light, and on loss of perfect vitality. I had long known that most of the bright red leaves met with in the fields were those which had been broken off from the plant, and yet when dried in the house, or even kept in the dark with their stalks in water, the green leaves fade to dull yellow. I therefore placed in my garden detached leaves with their stalks in the earth, some with the upper, and some with the lower surfaces exposed to the light, some in the sun, and some in the shade, and I found that those which turned to a fine red were those exposed to the sun with the lower surface upwards. I have also noticed that the red colour is often produced in spots where the leaf has been injured by insects; and in the case of other plants I have remarked that the leaves on partially broken twigs show this colour to unusual advantage. I am, therefore, disposed to attribute the formation of the red colouring matter to some change which takes place when the leaves are not actually dead, but in a state of very low vitality. Of course this is scarcely applicable to those in which a red colour is a normal constituent; but, at the same time, even then it may indicate more or less of the same kind of condition; for I have remarked that in those branches of the bilberry which are of a fine scarlet in the early part of the year, the form of the leaves departs considerably from the usual type, as if they were not altogether in a healthy state. Perhaps the fading of green leaves to yellow, and the normally yellow state of some leaves may be referred to a somewhat similar low vitality, which either permits the chlorophyll to become changed or prevents its formation, as in the case of plants growing in the dark. I may here say that there seems every reason to conclude that on further change the red colour so completely fades away as to produce little or no effect on the general tint, since faded red leaves cannot be distinguished from those of the same kind which were not red, and the artificial oxidisation with nitrite of potash, of the substances soluble in water, extracted from scarlet leaves of the bilberry, gives rise to exactly the same colour as in the case of the yellow or green leaves. I may also here say that when scarlet leaves are digested in hot water the red colour is easily removed, and the green, yellow, or brown colours left as the case may be.

In studying the further changes which occur in leaves in autumn, it is most important to understand the properties of the various colours allied to the chrysophyll group, since it is to them that we must attribute a great part of the more prevailing tints. On the whole, clean scarlets are uncommon in this country in the case of large trees, and simple bright yellows are not very abundant, or only last for a short time; since the chlorophyll seldom disappears entirely before the chrysophyll is more or less changed. Much remains to be learned with respect to the various kinds of chrysophyll, and the connection between each and the species or special variety of the plant, and the circumstance in which it is placed. As far as my present knowledge enables me to judge, there is some decided connection between the kind of colour and the species of tree, but, at the same time, I have met with entirely different colours in the same species growing in other situations, and I am even disposed to think that there may be individual differences, analogous to what is so common in the colour of the hair of animals. It is this complication of facts which makes it very difficult to explain the cause of some of the results, but, at the same time, this variation is in complete agreement with the varied tints of different trees of some species.

One of the most striking kinds of chrysophyll which has much influence on autumnal tints is that contained in yellow beech leaves. It is of pale yellow colour, but when dissolved in alcohol and oxidised by means of nitrate of potash and hydrochloric acid, it is changed to deep pink-red. When dissolved in water the oxidisation gives rise to a very copious precipitate of the same colour, which is, therefore, apparently only imperfectly soluble in water, but more easily in acid alcohol. This kind of chrysophyll appears not to be formed till the time when the leaves begin to turn yellow, since I found that green beech leaves contained much of another, which is often associated with the one just described in other trees. The yellow leaves contain the yellow xanthophyll, whereas the orange-brown leaves contain the orange modification, as though, perhaps, derived from the other by partial oxidisation. I have met with this kind of chrysophyll in the leaves of the bilberry, and in some varieties of plane, and in a less pure state in many others. Another species of chrysophyll found in many leaves may be procured from some varieties of the common elm. I have found that leaves of large size and loose texture give it in the most pure state, but in some it is mixed with much of the kind found in the beech, and in others is almost entirely replaced by a third colour, which is but little altered by nitrite of potash. The colour to which I wish, however, to call especial attention turns to a pink-orange when thus oxidised, and gives a spectrum with a sufficiently well-marked narrow absorption-band, in the centre of the green, and a fainter nearer to the blue; but after a while these bands fade, and the colour becomes orange-yellow. I have met with this colour in the leaves of the poplar, Spanish chesnut, alder, apple, and oak, and, as far as I am able to judge, there are very many trees whose leaves contain variable mixtures of this with that found in yellow beech.

I have met with a very special kind of chrysophyll in the leaves of a plane tree, which turns to a very fine yellow. This gives on oxidisation by nitrite of potash, a pink colour, with a very well-marked absorption-band in the green, nearer to the red end than in the case of that met with in the elm. In the green leaves of other planes of the same species I found only that colour so common in yellow beech leaves, and I have noticed that such plane leaves do not turn yellow, but to an orange-brown, modified by the continued presence of chlorophyll, though when this has been dissolved away by means of alcohol, the former colour can be very clearly seen.

It is very probable that other kinds of chrysophyll will be found on more extended examination, and that a more complete knowledge of their properties will serve to explain many facts which are still obscure. I have, indeed, even now good reason for believing in the existence of some others, but their characters do not differ sufficiently from those described to materially modify the general results.

The alcoholic solutions of all these various kinds of chrysophyll resemble one another in being changed by oxidisation with nitrate of potash and hydrochloric acid to pink-red substances, which alter more or less slowly into orange colours. When thus changed, and kept dry, or in solution with a slight excess of ammonia, they are further modified into various brown substances. This is well seen in the case of the red colour obtained from beech leaves, which, on the addition of ammonia, shows a well-marked absorption-band in the orange. This slowly disappears, and, after keeping for awhile, when evaporated to dryness, it is nearly as brown as burnt umber, and the addition of hydrochloric acid to the solution does not restore it to the original fine pink-red, but we have a decided brown colour, to some extent absorbing the red end of the spectrum, which was previously quite clear. All these modified colours, when dissolved in sulphuric acid diluted with an equal bulk of water, and still further oxidised by means of chlorate of potash, merely fade, and

are thus in that state of oxidisation which is characterised by a maximum depth of colour. These different changes may be simply due to an alteration of the chrysophyll, but, at the same time, there are cases which seem to indicate that almost, or quite, colourless compounds may contribute to the production of deep colours. For example, when the fresh leaves *Acuba japonica* are digested in cold alcohol, the solution evaporated to dryness, and treated with water, a clear yellow solution is obtained, which, when evaporated at a gentle heat, turns dark brown, on account of the formation of an insoluble substance of that tint. Water then extracts the apparently unaltered yellow substance: and, though these facts are an exception to the general rule, they seem to show that a dark colour may be formed independent of the previous existence of a colouring matter of the chrysophyll group.

Though some of the various phaiophyll colours are soluble in water, the proper solvent to extract them from the leaves is moderately strong alcohol, to which a few drops of hydrochloric acid have been added. Since they are almost insoluble in hot neutral alcohol, it is well to digest the leaves first in it, to remove some of the xanthophyll, and any other colour soluble in the liquid. After evaporating to dryness the solution in hot acid alcohol, any colour soluble in water should be dissolved out, and the insoluble portion digested in a cold mixture of alcohol and water, in equal parts, with a little hydrochloric acid, which dissolves much of the phaiophyll, and leaves an impure xanthophyll. After evaporating the clear solution to dryness, strong neutral spirit dissolves the more pure colour, which is always darker and browner when dry than when in solution. As thus obtained, it may be, and often is, a mixture of various coloured substances, and it is only by comparing those from different specimens of leaves that we can arrive at a satisfactory conclusion respecting them. For example, beech trees are occasionally found whose leaves turn in autumn to a very deep colour, almost exactly like burnt sienna. These yield a fine red phaiophyll colour which, when dry, is redder than burnt sienna, and almost exactly like so-called "light-red." When dissolved in alcohol it is of a fine pink-red colour, and corresponds in every particular with that obtained by oxidising the chrysophyll of yellow beech leaves as described above. The leaves of other beech trees turn to an orange-colour, like burnt sienna mixed with raw sienna, and these yield what appears to be a mixture of the above red colour with the browner modification into which the red passes, as already explained; and those leaves which have remained some time on damp ground contain still less of the red and more of the brown, which, when approximately pure, has a tint like that of a mixture of burnt sienna with burnt umber. Besides these, neutral alcohol or water extracts from the leaves a colour which closely corresponds with the orange modification already mentioned; and thus it will be seen that the actual tint of the leaves is the result of a mixture sometimes of at least six different colouring matters.

I have not been able to obtain from the leaves of the elm, chesnut, poplar, or oak, any pink-red colour corresponding to that first formed when the chrysophyll is artificially oxidised, but only the brown modification of burnt umber tint which corresponds almost exactly with what is formed on keeping the artificially oxidised in a dry state. This absence of the redder colour appears to be because it passes into the brown modification much more rapidly than the analogous colour in beech leaves, so that whilst they remain comparatively unaltered for weeks, those of the other trees just named often turn from light yellow to brown in the course of a day or two. The correspondence between the artificial and natural colours in these various cases is extremely close; and though the tint of many leaves is very much modified by the presence of other colours, yet I trust that the examples I have described will sufficiently well illustrate the fact that the most characteristic brown or orange shades are mainly due to the various kinds of phaiophyll, derived from the oxidisation of previously existing soluble compounds more or less characteristic of particular species or varieties of trees. The two principal kinds are those seen to advantage in the beech and in the Spanish chesnut or elm, but it seems as if they very commonly occurred mixed in very variable proportion, not only in different sorts of trees but in different leaves of the same, so as to give rise to every shade of redder or yellower brown, made more or less dull by the presence of more or less of the dark humus. Another very important modification of the tints is that dependent on the continued presence of chlorophyll, after the chrysophyll has been completely altered. This entirely prevents the development of any brilliant tints, since it makes what would otherwise be a fine orange-brown merely a dull brown-green, like that commonly met with in the faded leaves of the alder. In such cases, the chlorophyll is sometimes found to have been completely changed into the dull green modification produced by the action of acids on the brighter green kind. I need scarcely say that many leaves are variably and sometimes very curiously mottled, on account of the changes I have described having occurred partially and in patches. There seems to be a connection between some of these facts and the conditions under which the trees grow, and we cannot therefore be surprised that differences in climate, and variations in the weather of particular years, very materially modify the character of the prevailing tints. On this account, perhaps, some of the illustrations I have chosen may not be appropriate in all cases, being chiefly derived from the district with which I am most familiar.

The following table will serve to show the general relation of the various groups of colouring matters, their prevailing tint when alone, and the varying shades which result from the mixture of varying quantities of any of the two connected by brackets. I have also inserted on the left hand side the condition of the leaves of which, on the whole, the colours may be considered characteristic, commencing with perfect vitality, when carbonic acid is decomposed and oxygen set free, and ending with death and decomposition when the opposite change occurs.

Complete vitality and growth ..	Chrysophyll (gold yellow)	More or less bright green.
	Chlorophyll (deep green)	More or less green-brown.
Low vitality and change	Erythrophyll (crimson-red)	More or less red-scarlet.
	Xanthophyll (bright yellow)	More or less bright orange-brown.
Death and decomposition ..	Phaiaophyl (brown-orange)	Less or more dull brown.
	Humus (brown black)	

According to these principles, we must look upon the production of the fine tints of autumn as evidence of the diminished vital powers of the plants. I presume that this can admit of no doubt, and it agrees with the fact of unhealthy branches of a tree turning yellow whilst the rest remain green. The subsequent development of more sombre tints is evidence of more complete death. Perhaps some of my readers may think that such an explanation robs the fading leaves of autumn of much of their poetry, but, at the same time, I trust that the facts I have described may tend to explain many of the beautiful and varied tints which delight us so much in autumn, and that a knowledge of such general laws will compensate for any loss of poetic sentiment.—*Quarterly Journal of Science.*

Death of Dr. Wetherill.—With regret we announce the death of Dr. Charles M. Wetherill, of Bethlehem, Pennsylvania. Articles from his pen have often appeared in our columns; one of the most recent being "A Note on Itacolumite," in our issue of December 2nd, 1870. He had been a pupil of Liebig, and his American fellow-workers speak of him as one of the most active chemists America possessed.

FIRST REPORT OF THE ROYAL COMMISSION ON SCIENTIFIC INSTRUCTION AND THE ADVANCEMENT OF SCIENCE.

TO THE QUEEN'S MOST EXCELLENT MAJESTY.

May it please your Majesty,—

We, the commissioners appointed by Your Majesty to make inquiry with regard to scientific instruction and the advancement of science, humbly beg leave to present to Your Majesty the following first report:—

1. We have heard the evidence of witnesses in reference to the following subjects, forming part of our inquiry, viz.: the Royal School of Mines, the Geological Survey of Great Britain and Ireland, the Mining Record Office, and the Museum of Practical Geology, at present located in Jermyn Street; and also concerning the Royal College of Chemistry, at present lodged in a building in Oxford Street, which institutions are under one head, entitled Director-General of the Geological Survey of Great Britain and Ireland and Director of the Royal School of Mines.

2. There is no necessary connection between the direction of the Geological Survey of Great Britain and Ireland and the government of the Royal School of Mines.

3. The Royal School of Mines and the Royal College of Chemistry, which practically constitute one school of pure and applied science, are not organised in such a manner as to enable them to perform efficiently the work for which they were originally, or are, at present, intended. We base this conclusion upon three grounds: (*a.*) the absence of a chair of mathematics; (*b.*) the absence of physical or biological laboratories in which students can receive practical instruction; (*c.*) the insufficiency of accommodation in the Royal College of Chemistry.

4. The officers of the Geological Survey are greatly hindered in their work by want of accommodation; for although their number has been quintupled during the last 20 years, the space originally allotted to them has not been increased.

5. The space allotted to the Mining Record Office is already insufficient for the proper reception and arrangement of the valuable series of documents accumulated there, and for the accommodation of the public who desire to consult them.

6. The collections in the Museum of Practical Geology require greater space for their proper display than is at present afforded.

7. In order to provide a remedy for the inconveniences which have been enumerated, we recommend: (*a.*) That the building in Jermyn Street be given up to the Survey and to the Museum, with the reservation that the lectures to working men be delivered as heretofore in the theatre; (*b.*) That the building in Oxford Street be vacated by the Royal College of Chemistry; and (*c.*) That the Mining Record Office be lodged with the statistical department of the Board of Trade, or, failing accommodation there, in the building now occupied by the Royal College of Chemistry.

8. Without expressing any opinion, at present, as to the policy of government schools of science, your commissioners, having to deal with the Royal School of Mines and the Royal College of Chemistry as institutions which have existed for 20 years, and which, during that period, have turned out a large number of well-instructed students, consider that such steps should be taken as may be necessary to render their teaching thoroughly efficient.

9. With this object we recommend that the two institutions be consolidated; that mathematics be added to the courses of instruction now given; and that sufficient laboratories and assistance for giving practical instruction in physics, chemistry, and biology, be provided.

10. The institution thus formed (hereinafter called the "Science School") may be conveniently and efficiently governed by a council of professors, one of that body acting as dean.

11. We have further heard evidence concerning the buildings at South Kensington, now nearly completed, and intended for the reception of a projected school of naval architecture and science; and we recommend that the science school should be accommodated in these buildings. We have given careful attention to the considerations in favour of the retention in Jermyn Street of the technical instruction in certain branches, but we are of opinion that these considerations are outweighed by the great advantages to be derived from concentration.

12. We have further heard evidence concerning the Royal School of Naval Architecture and Marine Engineering, now conducted at South Kensington; and we recommend that the theoretical instruction of that school should in future be given in the science school, the general instruction in mathematics, physical science, and mechanical drawing, thus becoming common to both schools. We also recommend that no additional buildings, and no reconstruction of the temporary buildings at present occupied by the Royal School of Naval Architecture and Marine Engineering, should be undertaken until a further report has been received from this commission.

13. We have further heard evidence concerning the system of teaching elementary science under the science and art department; and we are of opinion that the quality of the instruction given under this department would be greatly improved if the teachers received practical instruction in elementary science. Such instruction has, indeed, already been given with marked advantage, although only to a limited extent. The science school will be available for the instruction of many science teachers throughout the country; but we reserve for a further report any expression of opinion as to the precise character of such instruction, and as to the conditions under which it shall be accessible.

14. The organisation of, and accommodation required by, the science school (including its technical branches), and the Royal School of Naval Architecture, will be dealt with in detail in a further report.

All which we humbly submit for your Majesty's gracious consideration.

(Signed)

DEVONSHIRE.	W. SHARPEY.
LANSDOWNE.	THOMAS H. HUXLEY.
JOHN LUBBOCK.	G. G. STOKES.
J. P. KAY-SHUTTLEWORTH.	HENRY J. S. SMITH.
B. SAMUELSON.	J. NORMAN LOCKYER, (*Sec.*)

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Friday, February 3rd, 1871.

SIR HENRY HOLLAND, Bart., M.D., D.C.L., F.R.S., President, in the Chair.

"*On some Experiments on Successive Polarisation of Light made by Sir C. Wheatstone,*" by W. SPOTTISWOODE, Esq., Treas. R.S. and R.I.

The experiments which formed the subject of this discourse were made by Sir Charles Wheatstone some years ago, but the pressure of other avocations delayed their publication. The term "successive polarisation" was applied by Biot to denote the effects produced when a ray of polarised light is transmitted through a plate of rock crystal cut perpendicularly to the axis. The plane of polarisation is found to be changed on emergence and through a different angle for each homogeneous ray. The

introduction of instrumental means for converting the plane polarisation of the ordinary apparatus into successive, or, as it is more commonly called, circular polarisation, and the explanation of the phenomena thence arising, constitute the main purpose of the communication.

Polarised light is distinguished from common light by the presence of certain peculiarities not ordinarily found; but the peculiarities in question cannot be discerned by the unassisted eye, and require special instrumental appliances for detection. A simple mode of bringing light into the condition in question is by allowing it to pass through a plate of the crystal called tourmalin, cut parallel to the axis; and if the light be then examined by causing it to pass through a second similar plate, held parallel to the former and caused to revolve like a wheel in its own plane, it will be found that the intensity alternately diminishes and revives, being zero for two positions 180° from one another, and a maximum for two positions at 90° from each of the former. Thus combination of tourmalins constitute, in fact, a polariscope, which in general consists of two parts, counterparts of each other, the first for bringing common light into the condition in question, in other words, for *polarising*; the second for examining or *analysing* the light.

The explanation of this fundamental phenomenon is as follows:—

The vibrations upon which the sensation of light depends, may, in ordinary light, take place in any direction in a plane perpendicular to the ray. By the process of polarisation they are all brought into one direction, still, however, perpendicular to the ray; so that throughout the entire ray they lie in one plane. On this account the polarisation here considered is called plane polarisation. There are other kinds of polarisation, such as circular and elliptic, whose names are derived from the curves, or orbits, described by the vibrating particles.

There are also other methods for producing plane polarisation beside that above described; *e.g.*, reflexion at particular angles from the surfaces of transparent media, transmission through parallel plates of glass, &c.; but as they all agree in reducing common light to the same condition, it is unnecessary for the present purpose to allude to them more in detail.

If a ray of polarised light fall upon a plate of doubly-refracting crystal, it is divided into two, whose vibrations lie in planes perpendicular to one another. These rays traverse the crystal with different velocities, and, therefore, emerge with a difference of phase. On entering the analyser the vibrations of both rays are resolved into one plane. If the plane of vibration of the analyser be parallel to one of those of the crystal, one ray will be cut off, the other will be transmitted without change. In any other position of the analyser the transmitted portions of the two rays will interfere so as to produce colour; and if the analyser be then turned through 90°, the portion of the original light cut off in the first position will be transmitted, and *vice versâ*.

Of this theory the following are the experimental results:—If a plate of doubly-refracting crystal, *e.g.*, selenite, be placed between the polariser and analyser, and turned round in its own plane, it will be found that in certain positions at right angles to one another, no effect is produced. These may be called neutral positions. In all other positions the field is tinted with colour, which is most brilliant when the plate has been turned through 45° from a neutral position. If the analyser be turned, the crystal remaining still, the colour will fade, and entirely vanish when the angle of turning amounts to 45°. From this position the complementary colour will begin to appear, and will be brightest when the angle of turning amounts to 90°. The colour depends upon the thickness of the crystal, so that by a suitable preparation any arrangement of colours may be produced.

So far for plane polarisation. The principle of circular or successive polarisation, as regards the present purpose, is as follows:—

If two sets of rectilinear vibrations lying in planes perpendicular to one another meet and combine, the resulting vibration will be curvilinear, whose form and position depends upon the difference of phase of the components. If the second set be in advance or in rear of the first by a quarter of a wave length, the resulting vibration will be circular; but the motion will in one case be direct (like the hands of a watch), in the other it will be reverse.

If two sets of circular vibrations in opposite directions meet and combine, the resulting vibrations will be rectilinear, and the position of its plane will depend upon the difference of phase of the components. If the second set advance upon the first, the plane of resultant vibration will undergo direct rotation; if it recede, it will undergo reverse rotation.

If in such an experiment white light be used, the vibrations of the different component prismatic colours will (on account of their different wave lengths) undergo different retardation; and, consequently, the resulting vibrations will lie in different planes, arranged in prismatic order. The order will be from red to violet, or *vice versa*, in accordance with the law stated above.

If a ray of plane polarised light fall upon a metallic reflector, it is divided into two, whose vibrations are respectively parallel and perpendicular to the reflector; and the latter is retarded behind the former by a difference of phase depending upon the angle of incidence. If the plane of vibration of the incident ray be inclined at an angle of 45° to the plane of incidence, the two rays into which it is divided have nearly the same intensity. At an angle, nearly 45° which varies with the metal employed, but which is perfectly definite, the intensities become accurately equal. And further, if the angle of incidence have a particular value dependent upon the nature of the metal (for silver 72), the retardation will amount to a quarter of a wave length. These two rays, on leaving the reflector, will re-combine, and in accordance with the laws above given, will, in the last-mentioned circumstances become a circularly polarised ray. Lastly, the direction of motion in this circular ray will depend upon the side on which the original plane of vibration is inclined to the plane of incidence; if, when it is inclined on one side, the circular ray becomes right-handed, then, when it is inclined on the other, it becomes left-handed.

Reverting then to the phenomena of double refraction produced by a plate of crystal cut parallel to the axis on a plane polarised ray; let the crystal be placed in such a position that the planes of vibration of the two resulting rays are inclined at angles of 45° on the two sides respectively of the plane of incidence; and let there be interposed between the crystal and the analyser a silver plate at an angle of 72° to the direction of these emergent rays. Each of these rays will, in virtue of the principles enunciated above, be converted by reflexion into a circularly polarised ray; but one will be a right-handed and the other a left-handed ray; and the difference of phase produced by the doubly-refracting plate will be undisturbed by the reflexion. This difference of phase depends, as is well-known, upon the wave length; in other words, upon the colour of the light. So that the two circular rays will combine to form a plane polarised ray, whose plane of vibration depends upon the difference of phase, *i.e.*, upon its colour. And if, finally, the light be then examined by an analyser in the usual manner, we shall have all the phenomena of circular or successive polarisation.

From what has been stated above, it appears that the direction of motion in the two circular rays, and, consequently, the order of colours produced, depends upon the position (to the right or left of the plane of incidence) of the ray which has been most retarded in the passage through the crystal plate. If, therefore, the plate being in a given position, the colours appear in an ascending order, then on turning the plate through 90° in its own plane, or on turning it over about an axis in the plane of incidence, the swifter and the slower rays will change position, and the order of colours will be reversed.

The reversal of the order of colour may be exhibited in

another way. Unianal crystals are divided into two classes: one, called positive (*e.g.*, quartz), in which the extraordinary ray moves more slowly than the ordinary; the other, called negative (*e.g.*, Iceland spar) in which the ordinary ray is the slowest. If, therefore, a plate of quartz placed with its axis at 45° on one side of the plane of incidence give the colours in one order, a similar plate of Iceland spar similarly placed will give them in the reverse order.

The same principles apply to the case of bianal crystals cut parallel to a plane containing the two optic axes. A ray of plane polarised light transmitted through such a plate is divided into two, whose vibrations respectively bisect the angles formed by the two axes; the line which bisects the smallest angle is called the intermediate section, and the line perpendicular to it the supplementary section; and the order of the colours depends upon the relative velocity of the two rays. In selenite the ray whose vibrations lie in the supplementary section is the slowest; in mica it is the swiftest. Hence these two crystals will, all other circumstances being alike, give opposite orders of colour, and may be regarded as positive and negative respectively, like quartz and Iceland spar.

The phenomena by which these principles may be illustrated are very numerous and varied, but are better seen than described.

NOTICES OF BOOKS.

Aunt Rachel's Letters about Water and Air. Longmans, Green, and Co. 1871.

ONE of the most important results of the present consideration of education is the improved tone of the text-books issued to the public. Works dealing with elementary science have long been such as afforded but poor introduction to the higher branches; written for children, they have been too childish. Aunt Rachel's Letters to Ned and Annie about Water and Air are eminently calculated to place before young minds the most important facts, even of the latest date, with regard to heat in relation to these substances. What Aunt Rachel has to tell about latent heat, the composition of water, the principles of the air-pump, thermometer, and the chemistry of combustion, is well told, in simple language; and, by placing it in the power of children to perform a few experiments themselves, an interest more than theoretical is likely to be engendered in their minds. It is to be hoped there will be found many aunts purchasing their sister's little work to give to their nephews and nieces.

Our Meat Supply from Abroad. A paper read before the Liverpool Literary and Philosophical Society, January 9th, 1871. By T. J. HUTCHINSON, F.R.G.S., F.R.L.S., &c., H. B. M. Consul for Callao, Peru. Liverpool: D. Marples. 1871.

OUR readers are doubtless acquainted with bisulphite of lime, a substance which, twenty-five years ago, was employed by Professor Melsens to prevent the rapid alteration of saccharine liquids. The main subject of this excellent lecture is the use of bisulphite of lime as prepared according to the patent of Messrs. Medlock and Bailey, being a preservative solution made of 1 gallon of bisulphite of lime solution, sp. gr. 1·050, ½-pint of common salt, and 4 gallons of water, for the purpose of preserving meat in a good and fresh state, not simply for a few days, but for several months, and even for years. The experience of Consul Hutchinson while at Rosario (Argentine Republic), confirmed by that of a large number of disinterested parties both in that and in this country, prove, as set forth in this pamphlet, the great value of the preservative solution alluded to. We need not enter into more details on this important subject, which, we hope, will soon lead to the importation, on the large scale, of meat of good appearance, nutritious quality, free from taste of chemicals, and, as stated by the above-named author, for sale here at from 4d. to 5d. per pound. The realisation of the first and second of these propositions the author states to have been proved, while the third may be considered very probable.

CORRESPONDENCE.

CONGELATION BY MEANS OF BISULPHIDE OF CARBON.

To the Editor of the Chemical News.

SIR,—Last winter, when using bisulphide of carbon with a spray producer, a hoar-frost concretion was rapidly formed on anything held close to the tube, so much so, as soon to close up the orifice. This is really frozen moisture entangled with bisulphide of carbon which communicates a strong smell and taste.

When the spray producer is used merely to force a jet of air into bisulphide of carbon, a film of hoar-frost immediately forms on the surface, and is, by the agitation, continually increased and mingled with the fluid so as to make it opaque. If the tube be now removed, these films start up to the surface and disappear, assuming curious linear forms.

On again directing the jet of air upon the fluid, the films soon unite and form small white frozen masses, and the sides of the vessel became incrusted therewith. Finally, both fluid and solid contents disappear. Here also, as at first, the concretions really consist of frozen moisture, tasting and smelling of the bisulphide of carbon with which it is entangled.—I am, &c.,

G. A. KEYWORTH.

MISCELLANEOUS.

Royal Institution of Great Britain.—The following are the arrangements for the Lectures after Easter, 1871:—On Tuesdays, April 18th and 25th, and May 2nd, William Pengelly, Esq., F.R.S., F.G.S., will deliver three lectures "On the Geology of Devonshire, especially of the New Red Sandstone." On May 9th and 16th, Charles Brooke, Esq., M.A., F.R.S., will lecture "On Force and Energy." On May 23rd and 30th, and June 6th, the Rev. Professor Haughton, M.D., F.R.S., will lecture "On the Principle of Least Action in Nature, Illustrated by Animal Mechanics." On Thursdays, April 20th to June 8th, Professor Tyndall, LL.D., F.R.S., will deliver eight lectures "On Sound;" and on Saturdays, April 22nd to June 10th, J. N. Lockyer, Esq., F.R.S., will deliver eight lectures "On Astronomy." The lecture hour is three o'clock. The following are the probable arrangements for the Friday Evening Meetings after Easter, 1871, to which Members and their friends only are admitted:—April 21st, Professor Blackie, F.R.S.E., "On the Pre-Socratic Philosophy." April 28th, Professor Odling, F.R.S. May 5th, W. R. S. Ralston, M.A., Trinity College, Cambridge, "On Russian Folk-Lore." May 12th, Professor Huxley, F.R.S. May 19th, Colonel Jervois, R.E., C.B., Secretary of the Defence Committee, and Deputy Director of Fortifications, "On the Defence of the United Kingdom." May 26th, Sir J. Lubbock, Bart., M.P., F.R.S., M.R.I., "On Relationships." June 2nd, Professor Thomas Andrews, F.R.S., Principal of Queen's College, Belfast, "On the Gaseous

and Liquid States of Matter." June 9th, Professor Tyndall, LL.D., F.R.S., M.R.I.

Glasgow.—Supper of Dr. Moffat's Chemistry Students.—The first supper of Dr. Moffat's Chemistry Students took place on Friday evening, the 17th inst., in the Waverley Hotel, Sauchiehall Street, Dr. Moffat in the chair, supported by Principal McCall, Drs. Charteris, Russell, Robertson, Colonel Shaw, Alex. Duncan, Esq., B.A., Secretary of the Faculty of Physicians and Surgeons, Glasgow, Messrs. Whitesmith, Stevenson, Bannerman, and others. Upwards of one hundred students were present, and, after a sumptuous supper, the chairman gave "The Queen" and other loyal toasts. Dr. Moffat, in replying to "The Chemistry Classes," referred to his commencing to teach chemistry in Glasgow six years ago; five years ago six students enrolled for laboratory work during the entire session. This session already there have enrolled no less than 132 laboratory students, and, with the veterinary pupils, eighty at lectures. There have been thirteen excursions to Chemical Works attended by nearly 400 students. The musical talent of the students was developed in a remarkable manner; Messrs. Maclaren, Batty, M'Kenzie, Fisher, Miller, Stevenson, and many others specially distinguishing themselves. A very happy evening was spent.

Scientific Curiosity Connected with the War Indemnity France is to Pay to Germany.—In order to give our readers the real gist of the following we retain some French words, explaining first that a milliard means a thousand millions. On the 31st of December next, there will not have elapsed a milliard of minutes of time since the beginning of the Christian era; that milliard of minutes will not be complete before the date of 28th of March, 1901. If, consequently, there had been put in a safe a five-franc piece every minute since the beginning of the era alluded to, the indemnity of 5 milliards of francs would not be paid off in capital—interest exclusive—before midday of the 28th of March, 1901. The five-franc piece has a weight of 25 grms., and the 5 milliards will, therefore, weigh 25 millions of kilos., a weight which, if loaded on railway trucks, each containing 5000 kilos. (5 tons), would require 5000 trucks; estimated in copper, the weight alluded to would be 500 millions of kilos., and would require 100,000 railway trucks for being conveyed. The diameter of the five-franc piece is 37 millimetres; if, therefore, 1 milliard of these pieces are laid down so as to join quite closely, this would give a length of 37 million metres = 37,000 kilometres, equal to 74 times the distance from Paris to Strasburg, which is 500 kilometres, and more than 32¼ times the distance from Paris to Berlin, =1134 kilometres. It would, therefore, be possible to pave, with 1 milliard of five-franc pieces, a road from Paris to Strasburg, which road would have a width of 74 five-franc pieces = 2·738 metres; or a similar road might be made from Paris to Berlin, and have a width of nearly 33 of the same pieces, that is, 1·20 metre. In order to cover a surface of a square metre, 730 five-franc pieces are required; 1 milliard of these pieces will, therefore, cover 136 hectares, 98 ares, 63 centiares; that is to say, nearly three times more than the surface occupied in the Champ de Mars at Paris by the Exposition of 1867, which only occupied a space of 46 hectares, but the indemnity to be paid is 5 milliard of francs which, put together, would cover a surface of 322 hectares, 10 ares, 75 centiares; that is, seven times more than the space occupied by the Exposition just named. When three pieces of five francs are placed upon each other, the height of the pile is equal to 8 millimetres; the height attained by piling upon each other 1 milliard of these pieces would be 2,666,666 metres, 66 centims., that is to say, if placed edgewise, flat on the ground, the height would be within 158½ kilometres, which is very nearly the distance from Paris to St. Petersburg. The kilo. of one and of five-franc pieces contains, in each case, 900 grms. of pure silver.—*Indépendance Belge.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus des Séances de l'Académie des Sciences, November 7, 1870.

This number contains the following original papers relating to chemistry and collateral sciences:—

Early Aërostatics and Aëronautics.—J. Dumas.—In his capacity as permanent secretary, this eminent *savant* read a portion of a report by Lavoisier, being appended to the *procès-verbaux* of the first meeting of a committee appointed by the old Academy of Sciences (as existing before the Revolution of 1789) to report on the aërostatic machines. The Committee held its meetings at the Hotel de la Rochefoucauld (the word hotel is here, as in many instances, simply used to indicate a large building, either public or private property—*e.g.*, Hotel de la Monnaie, Hotel de la Préfecture), on December 27th, 1783, the members present being the Duke de la Rochefoucauld, MM. Le Roy, De Condorcet, Tillet, L'Abbé Bossut, Lavoisier, Brisson, Berthollet, and Coulomb. As might be expected from the celebrated Lavoisier, his report sets forth very concisely, and with great precision, the principal points which should guide the Committee in its labours. It appears that a M. Meusnier had about that time invented certain apparatus for ascending in the air and for regulating the ascent, and, to some extent, direction of a balloon filled with gas (hydrogen), which apparatus is named after the so-called swimming bladder present in some kinds of fish.

Quantitative Spectral Analysis.—J. Janssen.—However valuable, this essay is not well suited for any useful abstraction.

Description of Telescope Specially Constructed for Military Purposes.—A. Cazin.—The detailed account of a contrivance whereby it is possible to observe, from behind a wall or earthworks, an army outside these means of defence.

Some Documents bearing upon the Domestic Economy and Food used in Ancient Egypt under the Ptolemies.—Dr. Egger.—This paper deserves attention on account of the scientific curiosities brought to light by the deciphering of rolls of papyrus used for writing certain records, in this instance, relating to the subjects above named.

November 14, 1870.

Reasons why the Food of Men and of the more highly-organised Animals ought to be of a Complex Chemical Nature. E. Chevreul.—This very lengthy and, as might be expected from the author, excellent essay, does not admit of any useful abstraction.

Tridodecuple or Decemdiurnal Period of the Atmospheric Phenomena, and on the Influence they Exert upon the General State of Health.—Ch. Sainte-Claire Deville.—This essay, the first part of a lengthy monograph on this subject, contains mainly a review of the bearing of facts meteorogically observed upon the general state of health of the inhabitants of a country.

Movements Executed by Birds while on the Wing.—Dr. Marey.—A mechanico-physiological paper illustrated by a series of woodcuts.

Thermo-Chemistry: Heat of Formation of Nitrogen Compounds.—Professor Berthelot.—This paper contains a series of tabulated results exhibiting the heat of formation of—binoxide of nitrogen; nitric acid; nitrates of potassa, soda, ammonia, lead, and silver; and of nitrates.

Aërostation: Experiments with the Giffard System, and Description of a Steam Air Balloon.—H. Giffard.

Nitroglycerine and Divers Kinds of Dynamite.—MM. Ch. Girard, A. Millot, and G. Vogt.—This paper contains the account of a series of experiments made with the substances alluded to; also on the best and safest means of preparing nitroglycerine on the large scale; and, lastly, lengthy details on the explosion, by percussion mechanically produced, of nitroglycerine mixed in various proportions with inert substances. It appears that dynamite, if left exposed to air for a length of time, becomes inactive.

November 21, 1870.

This number opens with a continuation of the monograph mentioned in the previous number by M. Ch. Sainte-Claire Deville. The other papers and memoirs relating to chemistry and collateral sciences are—

Dynamite, and its Applicability to Artillery and Warlike Purposes.—P. Champion.

Principle of a New Steerage System for Air Ballons.—Dr. Sorel.—Illustrated with a woodcut.

Preservation of Meat.—E. Pelouze.—This brief paper does not contain the description of the process by which the preservation is effected. It appears that the author has re-discovered a process for the preservation of meat which was invented about the end of last century by M. Vilaris, a pharmacist at Bordeaux, who had succeeded in preserving meat, while exposed to air, for several years, while analysis has never been able to detect in the meat any preservative agent. Considering the great importance of this subject, M. Pelouze, after consulting with M. Dumas, considered it best not to publish, at present, the particulars of the process, but to deposit with the Academy the samples and memoir under seal.

Influence which Coffee and Cacao exert as Food.—Dr. Rabuteau.—This paper contains the account of some experiments made with dogs, to which the author gave diets in one case consisting daily of 20 grms. of bread, 10 grms. of fresh butter, and 10 grms. of sugar; in the other case, 20 grms. of cacao, 10 grms. of sugar, and an infusion of 20 grms. of well-roasted coffee. From these experiments the author draws conclusions leading him to consider coffee and cacao as simply preventing de-nutrition. This view was objected to at the meeting by MM. Payen, Dumas, and Chevreul, whose lengthy discussions on this subject are reproduced. As regards cacao (commonly, but erroneously, in this country named cocoa), there can be no doubt that, containing as it does from 17 to 20 per cent of albuminous matter, with from 10 to 12 per cent of starch, from 40 to 50 per cent of fat, and among its mineral matter phosphates, it is food. M. Chevreul very properly observes, among other matters, the existence of idiosyncracy, and its influence on the individual tastes, and hence also more or less on the action of various alimentary substances, pointing out that he himself has, from his earliest years, an invincible repugnance against wine, milk, fish, and various vegetables, none of which he ever partakes of, but for all that it would, of course, be absurd to deny the nutritive properties and value of these substances.

Historical Notice on the Domesticated Cat of the Ancients, more especially Egyptians.—F. Lenormaut.

Stratigraphical Relation existing between divers Meteoric Rocks.—S. Meunier.

Effect of Various Phenic Acid Preparations against Small Pox.—Dr. Bobœuf.—The author recommends the internal and external use of *phénol sodique*, phenate of soda, as safe, and as also preventing pitting.

Les Mondes, March 2, 1871.

This number, the first we have received after the publishing of this periodical has been resumed, opens with an address especially addressed to the French readers. Among the original communications we notice the following:—

Extract from a Letter from M. C. Woestyn to the Editor.—This contains the following particulars bearing upon the beet-root sugar industry:—In Italy, MM. Tomassini, Guarieri, and Castellani have obtained a concession from the Government to manufacture, for a period of fifteen years, beet-root sugar, to be free from excise duty. At Valenciennes, M. Margueritte's process for the extraction of sugar from molasses by means of alcohol was carried on last winter on the large scale, and has given excellent results, since the quantity obtained has been 36 per cent greater than the laboratory assays. The Seyfert process (sulphurous acid) has been eminently successful at Arlowetz and in Belgium, and is also adopted in several sugar refineries at New York.

Death of Professor Morren.—Our readers will hear with regret of the demise of this *savant*; he died at Marseilles in October last, in the 69th year of his age.

Powerful Centrifugal Pumps.—MM. Neuf and Dumont.—An account of some work effectually performed by simple and readily manageable machinery under very exceptional conditions—viz., the filling with water of dry moats of a total length of more than 6 kilometres, and requiring the lifting of nearly 4,000,000 cubic metres of water (equal to as many tons' weight), to a height of 8 metres, a work actually performed in a few days. Some of the pumps made by the firm named discharge a cubic metre of water (1 ton weight) every second of time.

This number contains the index for the numbers published for last year.

American Journal of Pharmacy, March, 1871.

Leaving the papers more particularly bearing upon pharmacy, we notice the following:—

Glycerine, its Quality as it Exists in Commerce.—J. P. Remington.—This paper contains the account of a series of researches made by the author on six different samples of American glycerine. The specific gravity varied from 1·254 to 1·240. Three samples were colourless, two yellowish, and one quite dark. Odour when warm varied from none at all to fatty and empyreumatic. Precipitate with nitrate of silver—2 none, 1 heavy white, 2 rose colour. Action of sulphuric acid—4 discoloured, 2 slightly so; none contained sulphate of lime; 4 were quite free from all lime. Action of ferrocyanide of potassium—1 a precipitate, 2 opalescent, 1 clear, 2 slight precipitate; with hydrosulph. of ammon.—1 a slight precipitate; with chloride of barium—3 no precipitate, 1 slight precipitate, 1 precipitate, 1 opalescent. All samples free from sugar; and on being tested for ethyl-butyrate—5 slight odour and 1 very slight. Therefore these samples are, on the whole, good specimens of the article as sold in the United States.

Presence of Manganese in Beech Nuts.—Dr. J. E. De Vry.—After referring briefly to a sentence in the introductory address of the chairman of the last Pharmaceutical Conference, bearing upon the presence of manganese in the ashes of the beech and birch, the author states that, while studying in Germany, now some thirty years ago, he collected beech-nuts in the vicinity of Giessen, and found the ashes of these nuts to contain a rather large percentage of manganese, which was readily explained by the fact of that mineral being present in that locality rather abundantly. In 1847, being at the meeting of the British Association at Oxford, the author gathered some unripe beech-nuts in Blenheim Park, which, on being afterwards tested, were found to contain a relatively large amount of manganese, although grown in a very different soil. A third analysis of the ashes of beech-nuts, collected in the wood of the Hague, confirmed the same fact.

Freezing-Point of Mixtures of Glycerine and Water.—C. Bullock.—The glycerine used was common, sp. gr. = 1·250 = 29° Baumé; quantity of water in all experiments, 1 gallon. Temperatures Fahr., with ½ pint, fuses at 30°, 1 pint at 24°, 1½ pints at 18°, 2 pints at 10°, 3 pints remain fluid at 3°.

Annalen der Chemie und Pharmacie, February, 1871.

The following original papers and memoirs are contained in this number:—

Researches on Substituted Phenols; Part I. Chlorphenol-Sulpho Acids.—T. Petersen and R. Baehr-Predari.—This part of an exhaustive monograph contains the following sections:—Chlorphenol; ortho-chlorphenol-sulpho acids; α chlorphenol-sulpho acid (ortho-mono-chlorphenol-meta-monosulpho acid) salts; potasssium salts, illustrated with several crystallographic diagrams; ethyl-α-chlorphenol-sulpho acid (α-chlorphenetol-sulpho acid); isomers of the α-chlorphenol-sulpho acid; β-chlorphenol-sulpho acid (ortho-mono-chlorphenol-para-mono-sulpho acid); chlorphenol-disulpho acids; action of concentrated nitric acid on the chlorphenol-sulpho acids; dinitro-chlorphenol fusing at 80·5° (α-chlor-dinitro-phenol of MM. Faust and Saame); dinitro-chlorphenol fusing at 114°; mono-nitro-dichlorphenol fusing at 106°; dinitri-chlorphenol fusing at 69°; constitution of the nitro-chlorphenols; monochlor-mononitro-phenols; monochlor-dinitro-phenols; trichlor-mononitro-phenols and trichlor-dinitro-phenols; review of the bodies treated of with their formulæ.

Researches on the Consititution of Diamylen.—W. von Schneider.—This lengthy essay is so full of lengthy and complex formulæ, all bearing upon the elucidation of the constitution of diamylen ($C_{10}H_{10}$), that the contents of the paper, however valuable, are not suited for useful abstraction.

Juice contained in the Muscles of the Phocæna communis.—Dr. O. Jacobsen.—This paper contains the detailed account of a series of experiments made with the juices of the flesh of the dolphin, and compared with that of horses. 10,000 parts of the former gave—Kreatine, 6·10; sarkine, 1·05; xanthine, a trace; inosite, 0·08; lactic acid, 7·45. Of the latter—Kreatine, 7·6; sarkine, 1·28; xanthine, 0·11; inosite, 0·30; lactic acid, 4·47; taurine, 0·70.

Investigation of Indian Geranium Oil.—Dr. O. Jacobsen.—The essential oil alluded to exhibited a faintly acid reaction to test-paper; colour, greenish yellow; sp. gr. at 20°, 0·887. The author treats at length on the products yielded by fractional distillation of this oil; next on geraniol, $C_{10}H_8O$, a liquid, sp. gr. at 15° = 0·8851, optically inactive; and on the combinations of that body with chlorine, $C_{10}H_{17}Cl$, bromine and iodine, cyanogen, sulphur, and lastly on geraniol ether, $C_{30}H_{34}O$.

Investigation of a Very Hard and Compact Swedish Peat.—Dr. O. Jacobsen.—Sp. gr. of the peat—1·07; hygroscopic moisture, 11·5 per cent; the dry substance contained 5·02 per cent of ash. Composition, in 100 parts—Ash, 5·02; carbon, 51·38; hydrogen, 6·49; nitrogen, 1·68; oxygen, 35·43.

Some of the Combinations of Chloral with Alcohol and with Amides.—Dr. O. Jacobsen.—This essay contains the following sections:—Chloral hydrate; chloral methyl, amyl, alcoholate; chloral alcoholate; chloral acetyl alcohol; chloral acetamide; chloral benzamide; chloral urea.

Polytechnisches Journal von Dingler, second number for February, 1871.

Combination of the Interference Scale with the Photographic Spectrum Scale.—Dr. J. Müller.—An optico-algebraical essay.

Calcination of Sulphur-Containing Ores, and Description of a Newly-Devised Calcination Furnace.—R. Hasenclever and W. Helbig.—This excellent essay bears upon the best method of utilisation of pyritic ores for the purpose of sulphuric acid manufacture; but, since the paper is illustrated by several engravings required for the proper understanding of the description, we cannot enter into any details here.

Account of some Experiments made with the view of Utilising Burnt Iron Pyrites for the Production of Metallic Iron.—Dr. E. Richters.—Reserved for full translation.

Pyrometrical Assay of a Kaolin found near Strehlen, in Silesia, and Chemical Analysis of the Material obtained from it by Schlamming.—Dr. C. Bischof.—After describing the locality and other local conditions under which the mineral alluded to has been discovered, the author gives a detailed account of the pyrometrical testing of the mineral as found, and of the same schlammed. Both materials were heated up to the melting-point of platinum; in each instance the materials withstood this high temperature without fusion,

and showed also a white colour. The results of the analysis are, in 100 parts—Alumina, 37·54; silica in chemical combination, 44·08; silica as sand, 2·62; magnesia, 0·23; lime, 0·08; peroxide of iron, 0·94; potassa, 0·84; chemically-combined water, 12·60; hygroscopic water, 0·66;—total, 99·53. Formula, $13{,}10(Al_2O_3{,}1{,}42SiO_3)+RO$.

Constituents of the Water of the Rhine at Cologne, and on the Use that can be made of that Water for Domestic Purposes.—Dr. H. Vohl.—The introduction to this excellent paper contains a *resumé* and general review of the water of rivers. The purest known to exist at present is the water of the small Swedish river Loka, which, in 100,000 parts, contains only 0·434 part of mineral substances; while the Thames at London Bridge contains, in the same quantity of water, from 69 to 70 parts; the Seine, in Paris, 23 to 24; and the river Jordan from 130 to 131 parts of mineral substances in the same quantity of water. The paper next contains, in full details, the analysis made of the water of the Rhine opposite Strasburg (1848), by Sainte-Claire Deville; the water of the Rhine at Arnhem (Netherlands), by Dr. J. W. Gunning (1853); and also three former analyses of the Rhine water at Cologne, drawn from that river at different localities opposite the city alluded to, made in 1853, 1855, and 1861. The analyses of the author of this paper are no less than twelve in number, the water being drawn at three different places and at various periods, and are by far too extensive and lengthy to be here quoted in full. We can only observe that the quantity of solid matter present in the Rhine water at Strasburg, as compared with that quantity at Arnhem, shows a decrease of 31·242 per cent for the water at the last-named place, a phenomenon due to loss of carbonic acid. 10,000 parts of Rhine water at Strasburg contain, of total solid mineral matter, 2·317; at Arnhem, 1·593; at Cologne, varies from 2·503 to 2·443 and 2·30.

Description of a Stove which admits of Very Precisely Regulating the Consumption of Fuel and the Desired Degree of Temperature Required in Rooms.—Dr. Meidinger.—Illustrated with woodcuts.

Annalen der Physik und Chemie, von Poggendorff, No. 1, 1871.

Relation Existing between the Hemihedric Crystalline Form and the Thermo-Electric Condition of Iron Pyrites and Cobalt Glance.—Dr. G. Rose.—This lengthy monograph, illustrated by a series of engravings, is, notwithstanding its intrinsic value, not well suited for abstraction.

Designation of Hemihedry in Application to the Stereographic Projection.—E. Reusch.—A mathematico-crystallographical paper illustrated with a series of engravings.

Electrical Oscillations in Induced Conductors.—J. Bernstein.—This monograph, illustrated by a series of engravings, is divided into the following sections:—Description of apparatus; course of the induced current in the secondary coil of an induction apparatus; electrical condition of the secondary coil when the primary coil is disconnected; condition of the primary coil at the time of disconnecting it from the source of electricity.

Influence Exercised by the Density and Temperature on the Spectra of Gases Heated to Redness.—F. Zöllner.—Algebraico-physical essay.

Mineralogical Contributions.—E. E. Schmid.—This crystallographico-mineralogical essay, illustrated by engravings, contains the following chapters:—On whewellite and forms connected therewith; on desmin—

$$\left(\begin{matrix}CaO\\NaO\end{matrix}\right\} = SiO_3\Big) + (Al_2O_3 + 3SiO_3) + 6HO\,;$$

on mesolite.

Cooling and Conduction of Heat in Gases.—Dr. F. Narr.—This lengthy memoir is divided into the following chapters:—Introduction; description of apparatus, of the mode of experimenting, and of the method of calculating the results; results of experiments in a tabulated form; theoretical deductions drawn from the experiments.

A New Experiment, and some Observations on the Theory of Leidenfrost's Drop.—E. Buelde.—Illustrated by woodcuts.

Anomalous Dispersion of Light on Bodies Superficially Covered with Colour.—A. Kundt.—An algebraico-optical essay.

Observing of the Sun's Protuberances in Monochromatic Light.—Dr. W. Zenker.

Bulletin de l'Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 12, 1870.

This number contains the following original papers and memoirs bearing upon physico-chemical and collateral sciences:—

Aurora Borealis observed at Brussels on the 19th of November, 1870.—A. Quetelet.

Periodical Appearance of Meteorites in November, 1870.—A. Quetelet.

Description of a Pocket Stereograph.—J. Plucker.

Review of the Progress Mineralogical Science has made in Belgium during the last thirty-five years.—G. Dewalque.—A lengthy lecture on this subject, containing, in condensed form, all that has been done in the country alluded to in scientific, as well as practical geology, mineralogy, mining, and quarrying, with quotation of the titles of a very large number of books, maps, and other printed and published works.

NOTES AND QUERIES.

Ferricyanide of Potassium in Photography.—In Mr. Vogel's paper, published in No. 2 of the "German Chemical Society's Report!" for 1871, and extracted by you on the 24th inst., I read that this gentleman has just discovered a method of applying the action of ferricyanide of potassium in photography. I beg to mention that, in the year 1865, I used a paper prepared with that salt for the same purpose, and obtained, on exposure under a negative, very good results, the image being subsequently intensified by treating with a mixed solution of perchlorides of iron and tin, and fixed by simple washing with water. Some photographs prepared by this process I still have by me.—Rowland J. Atcherley, Ph.D.

Valonia.—Some time since, a letter appeared in your "Correspondence" from C. A. Cameron, of Dublin, enquiring why Smyrna valonia commanded a higher price than Greek, as by analyses he had ascertained the amount of tannic acid in both to be nearly alike. This may be accounted for in two ways. First, the prejudice is certainly on the side of Smyrna, as both in brightness of colour and strength it generally exceeds the Greek. The majority of tanners are unable to prove, by chemical tests, the percentage of tannic acid, and are dependent alone on the use of the hydrometer, which simply gives the density. Secondly, the season is a remarkable one, the crop of valonia, being very deficient in tannic acid. This especially refers to Smyrna, the majority of the Greek being about the usual average in strength. My own experience corroborates Mr. Cameron's analysis; one sample of Greek, worth, or rather selling price, £14 10s., contained 20·47 per cent of tannic acid. When a sample of Aidin, the best valonia, selling now for £18, contains only 22·92 per cent of tannic acid. Two or three years since, the best Aidin valonia stood 35·22 per cent. This will, I hope, explain the apparent disproportion in the price of the two valonias.—W. N. Evans.

Anthracene.—(Reply to "Anthracen.")—According to Dr. J. R. Wagner (*Jahresberichte über die Fortschritte der Chemischen Technologie*, vol. xv., p. 598), the following process may be used:—Estimate first the point of fusion of the *green grease*; next, take from 5 to 10 grms. thereof, place it between a thick layer of sheets of filtering paper, and press strongly between previously well warmed metal plates, and weigh the material after that. Boil next with alcohol; repeat this with precisely the same bulk of alcohol twice, or oftener; cool, filter after cooling, wash the residue with cold alcohol, and weigh the residue as being nearly pure anthracen. After that, estimate again the point of fusion of the residue, which point should be 210°.

Anthracene.—In reply to "Anthracen," there does not appear to exist any process by which the amount of anthracene can be determined in the commercial article with any exactitude. A process, however, can be given by which comparative results may be obtained of sufficient accuracy for most commercial purposes. The melting-point should first be determined, and, if the substance be in a pasty form, a certain weight is taken and pressed in blotting-paper between two plates previously warmed; but, if it be in a powder or solid, this may be dispensed with. It is now well washed with cold alcohol, and if a series of determinations are to be made the same amount of alcohol must always be used. If the distillation of the tar has not been pushed beyond a certain point, the substance should be nearly pure anthracene, and if the melting-point be from 210° to 215° it may be weighed as such. This process will yield tolerably fair comparative results. If, however, the distillation has been carried further, hydrocarbons higher in the series are obtained, and which will be present in the residue left by washing with alcohol. The existence of chrysen may be known by the bright yellow colour of the residue. To separate this substance, recourse must be had to carbon disulphide, in which it is only slightly soluble. The difference between the weights before and after treatment with the carbon disulphide will give the amount of anthracene. The chrysen is left as a pure yellow powder fusible at about 240° C. To take advantage of the different degrees of solubility of the various hydrocarbons seems to be the only way as yet of estimating their amounts; and it may be assumed as a general rule that they are soluble in their more common solvents inversely in proportion to the weight of their melting-points, chrysen being much less soluble than anthracene, and the latter than naphthaline. In Dingler's *Polytechnisches Journal*, vol. cxcvi., p. 543, there is an interesting paper by Dr. Gessert, "On the Manufacture of Anthracene," from which some of the above facts are taken. Dr. Gessert states that 100 parts of alcohol, benzol, or carbon disulphide dissolve, respectively, 0·6, 0·9, and 1·7 parts of anthracene, and that the homologues higher than that hydrocarbon are prejudicial to the manufacture of alizarine. It would be interesting to know if the same remark applies to naphthaline; will some of your correspondents give information on this point?—Eureka.

MEETINGS FOR THE WEEK.

Monday, April 3rd.—Medical, 8.
—— London Institution, 4.
Tuesday, 4th.—Zoological, 9.
—— Civil Engineers, 8.
Wednesday, 5th.—Microscopical, 8.
—— Pharmaceutical, 8.
—— Geological, 8.
Thursday, 6th.—Chemical, 8. W. Mattieu Williams, "On Burnt Iron and Burnt Steel." Henry E. Armstrong, "On the Formation of Sulpho-Acids."
—— London Institution, 7.30.

THE CHEMICAL NEWS.

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ON ANTHRAFLAVIC ACID,

A YELLOW COLOURING MATTER ACCOMPANYING ARTIFICIAL ALIZARINE.

By EDWARD SCHUNCK, Ph.D., F.R.S.*

THE artificial formation of alizarine is a process of so much importance both theoretically and practically, being, in fact, the first instance in which a natural colouring matter has been produced by artificial means, that everything connected with it must in the eyes of the chemist possess more or less importance, especially when we consider that it is chiefly to alizarine that madder owes its valuable dyeing properties. The process itself, as described by its discoverers, Gräbe and Liebermann, seems exceedingly simple, and consists in the conversion of the hydrocarbon anthracene, $C_{14}H_{10}$, by the action successively of an oxidising agent, of bromine or sulphuric acid, and of caustic alkali, into alizarine, $C_{14}H_8O_4$. Nevertheless, the product obtained on a large scale for the use of dyers and printers by this process is very far from being pure alizarine; so far, indeed, that some persons are inclined to doubt its perfect identity with the natural substance. Its solution in caustic alkali, for instance, has not the fine violet colour of a solution of pure alizarine, but is more or less purple or even red, and it differs in other respects. Now, though I have never entertained much doubt as regards their identity in the main, it might, I fancied, be interesting to ascertain whether the differences observed between the natural and artificial products were due to impurities accompanying the latter or not, for though these impurities, if present, might not cause any injury or inconvenience during the dyeing process, they might possibly be formed at the expense and take the place of alizarine, and thus be a source of loss to the manufacturer. Now a few simple experiments are sufficient to prove that artificial alizarine as ordinarily prepared is always accompanied by other substances, some of which are coloured while others are colourless or nearly so. My object on the present occasion is to describe one of these substances and to point out the relation in which it stands to alizarine.

My attention was first directed to this part of the subject by the results of some experiments made on a small scale to obtain alizarine from anthracene according to the directions of Gräbe and Liebermann. I was surprised to find that in spite of all the precautions taken I always obtained besides alizarine a notable quantity of another body also crystalline, but dissolving in alkalies with a yellow colour. This body bore so strong a resemblance in some of its properties to several of the rubiacine class of colouring matters, substances which are contained in madder along with alizarine, that my curiosity was excited. Having communicated this fact to Mr. Perkin, who, as is well known, is engaged in the manufacture of alizarine on a large scale, he kindly sent me for examination a specimen of the residue obtained by him in evaporating the mother liquors of alizarine. This residue was a crystalline, reddish-brown mass, soluble in alkalies, with a cherry-red colour. I found it to contain in addition to alizarine a quantity of a substance apparently identical with that I had previously obtained directly from anthracene. I afterwards found the same body in commercial alizarine, both in that manufactured by Mr. Perkin and in a sample from a continental firm. I therefore requested Mr. Perkin to supply me with a quantity of his alizarine sufficient to enable me to prepare a pure specimen of this body, a request to which he very kindly acceded.

This alizarine, which was a yellow, almost amorphous powder, was in the first place treated with dilute caustic soda, in which it dissolved for the most part, yielding a dark purple solution. A small qnantity of a pale yellow powder was left undissolved, which was filtered off, washed, dried, and heated, when it yielded crystals of anthraquinone. To the purple liquid there was added an excess of acid, which produced a bulky brownish-yellow precipitate. This was filtered off, and treated with boiling alcohol until the whole was dissolved. The alcohol on cooling deposited a quantity of almost pure alizarine in small mica-like scales. The mother liquor of course contained alizarine, and in order to separate it acetate of lead was added, which gave a bulky purple precipitate of the lead compound of alizarine. The filtered liquid, which had a dark yellow colour, was evaporated, when it left a yellowish-brown residue, consisting for the most part of the yellow colouring matter or acid. In order to separate the latter from the impurities accompanying it the residue was treated first with water, and then with cold alcohol. It was then dissolved in dilute caustic soda, and to the boiling solution chloride of barium was added. The filtered liquid deposited on cooling a mass of small shining crystals of the barium salt of the acid. These were purified by re-crystallisation from boiling water, and then treated with hydrochloric acid. The lemon-yellow flocks left by the acid were filtered off, washed, and dissolved in a little boiling alcohol. This on cooling deposited a quantity of yellow silky needles, consisting of the acid, which I have named *anthraflavic acid*, in order to indicate its source and its most obvious external property.

The chief properties of this acid are these:—When crystallised from alcohol and dried, it has the appearance of a dark lemon-yellow silky mass, which under the microscope is seen to consist of slender four-sided prisms. When heated on platinum foil it gives off copious yellow fumes and then burns with a luminous flame without leaving any residue. When cautiously heated in a tube or between two watch-glasses, it may be almost entirely volatilised, yielding a vapour which condenses in the form of a yellow sublimate. This sublimate consists of small lustrous crystalline plates, which, examined under the microscope, exhibit very regular outlines. The acid is only slightly soluble in boiling water, and almost insoluble in cold. It is more soluble in alcohol and ether, but insoluble in boiling benzol and sulphide of carbon. It dissolves readily in concentrated sulphuric acid even in the cold, forming a dark yellow solution, from which it is precipitated by water in yellow flocks. It is not much affected by dilute nitric acid even on boiling. With fuming nitric acid it yields a so-called nitro-acid, to which I shall return presently.

It is the fact of this substance yielding with bases compounds of well-defined character, some of them being regularly crystallised, that entitles it more especially to be classed among acids. When an alcoholic solution of anthraflavic acid is mixed with an alcoholic solution of potash, it assumes a dark yellow colour, and deposits on standing long orange-coloured needles arranged in stars and possessed of considerable lustre. The sodium compound prepared in the same manner crystallises in needles and resembles the potassium salt, but is lighter in colour. The ammonium salt may be obtained by dissolving the acid in boiling absolute alcohol and adding a slight excess of ammonia; on cooling, the solution deposits dark yellow lustrous crystals. These crystals, however, after a short exposure to the air, lose the whole of their ammonia, leaving a yellow residue consisting of the acid itself. This inability to retain ammonia even at the ordinary temperature of the atmosphere is a proof of the feeble nature of the acid. The potassium and sodium salts are also rather unstable compounds, for if it be attempted to re-crystallise either of them from boiling water a portion

* Read before the Manchester Literary and Philosophical Society, March 7th, 1871.

of the acid separates, the solubility of the base in water being sufficient to overcome its affinity for the acid. Anthraflavate of barium may be obtained by dissolving the acid in boiling baryta water, or by adding chloride of barium to a solution of the substance in caustic alkali. It is deposited from its watery solution in small shining plates, and after being filtered off and dried has a fine maroon colour. Under the microscope it is seen to consist of small crystals with very regular outlines. It may be re-crystallised from water without decomposition. The strontium salt is very similar, being soluble in boiling water and crystallising in long needles. The calcium salt is, however, insoluble in water, and is precipitated in orange-coloured flocks on the addition of chloride of calcium to an ammoniacal solution of the acid. On adding sulphate of magnesium to a solution of the acid in ammonia no precipitate is produced, but on standing some time the magnesium salt is deposited in dark yellow crystalline plates and needles arranged in star-shaped clusters and possessed of much lustre. The aluminium compound, when prepared in the same manner, appears as a yellow deposit consisting of microscopic crystals. The ammoniacal solution gives with acetate of lead a voluminous orange-coloured precipitate, with acetate of copper a light brown, and with nitrate of silver a reddish-brown precipitate. The other compounds are of no particular interest.

All the compounds of the acid which are soluble in water yield yellow solutions; none are red. It is chiefly the presence of this acid in crude alizarine which affects the colour of the alkaline solution, changing the violet due to alizarine into purple, or when present in larger quantity, into red. For the same reason an alkaline solution of crude alizarine does not show the absorption-bands in the spectrum so distinctly as one of pure alizarine. Alkaline, as well as alcoholic solutions of anthraflavic acid, absorb the blue end of the spectrum very powerfully, though no bands are visible, even with very dilute solutions. A solution of the acid, in concentrated sulphuric acid, if not too dark, shows, however, a broad but well-defined absorption-band at the extreme edge of the blue, bordering on the green, accompanied by a total absorption of the violet as seen with the other solutions.

Anthraflavic acid dissolves very readily in fuming nitric acid even in the cold, yielding a deep yellow solution, which, on standing for 24 hours, becomes lighter in colour, without evolving any gas. On now adding water a quantity of light yellow shining crystals is deposited. These, when filtered off, washed, and dried, resemble anthraflavic acid. They are, however, totally different in their properties, and consist, there can be no doubt, of a so-called nitro-acid, in which one or more atoms of hydrogen are replaced by NO_2. When heated they deflagrate, and they give a potassium salt crystallising in yellow needles, very little soluble in water, and resembling picrate of potassium. Want of material has prevented my examining this product more fully.

Though anthraflavic acid yields intensely yellow compounds with bases, it seems to possess no dyeing properties. The freshly precipitated acid suspended in water communicates not the least tinge of colour to alumina and iron mordants on calico, however long the liquid may be boiled. Its presence in artificial alizarine is therefore of no consequence as regards the dyeing qualities of the latter.

The composition of anthraflavic acid is expressed by the formula $C_{15}H_{10}O_4$. That this is the true formula was proved by an examination of the silver and barium salts. The formula of the first is $C_{15}H_8Ag_2O_4$; that of the second $C_{15}H_8BaO_4+H_2O$. The additional molecule of water attached to the barium salt is not driven off by heating to a temperature of 120°C. The acid is therefore bibasic. Hence it appears that this substance and alizarine stand in a very simple relation to one another. They are homologous bodies. Anthraflavic acid may be viewed as alizarine in which an atom of hydrogen is replaced by methyl. Though the great difference in properties, and especially the far greater stability of the acid, might lead to the inference that it is only as regards their composition that the two substances approach one another, a very simple experiment is sufficient to prove that they are in fact very closely related. If pure anthraflavic acid be dissolved in an excess of caustic potash, and the solution be boiled down to dryness, a yellow residue is left, which, after being carefully heated almost to fusion, dissolves in water with a red colour. This solution contains alizarine, as it shows the absorption-bands in the spectrum peculiar to the latter, though not very clearly on account of undecomposed anthraflavic acid still present. Pure alizarine may, however, be obtained from it, by simply adding an excess of acid, filtering off the flocculent precipitate, dissolving the latter in alcohol, and adding to the solution acetate of lead, when a purple precipitate falls, which contains the whole of the alizarine, the excess of anthraflavic acid remaining in solution. From the lead precipitate alizarine may be obtained having all the properties of that substance. It is certain, therefore, that by the action of caustic potash, anthraflavic acid is converted into alizarine, the process being doubtless one of oxidation, though it should be stated that the conversion is never complete, probably because the action, if carried far enough to convert the whole of the acid, leads to the decomposition of the alizarine already formed. I am at present occupied with some experiments for the purpose of substituting an atom of hydrogen in alizarine by methyl, and thus forming anthraflavic acid synthetically. It is evident that the acid cannot be considered as a methylic ether of alizarine, since both substances combine with two atoms of base to form neutral compounds. If the substitution by methyl be possible, it must therefore take place in the radical of alizarine. The possibility of such substitutions is allowed by Gräbe and Liebermann, who consider chrysammic acid, for instance, as anthraquinone in which 4H are replaced by $4NO_2$. Should the synthesis just mentioned succeed, it will, I imagine, throw some light on the constitution of the so-called yellow colouring matters of madder, such as rubiacine and rubiadine, which certainly contain 16 atoms of carbon, and may possibly turn out to be substitution products of alizarine.

In what manner anthraflavic acid, with its 15 atoms of carbon, is formed from anthracene, which contains only 14, is not very clear. I imagined it to be just possible that the anthracene employed for preparing the alizarine supplied to me might have contained a higher hydrocarbon, say $C_{15}H_{12}$ or methylanthracene, which, by oxidation, would yield methylanthraquinone, and at the end of the process methylalizarine. On requesting Mr. Perkin to favour me with his opinion on this point, he informed me, however, that my supposition was improbable, because the alizarine which he sent me was prepared from nearly perfectly pure anthraquinone, which had been distilled and crystallised from benzol.

Another point remains to be considered in connection with this subject. It is well known that the beautiful discovery of the mode of forming alizarine was the direct result of a previous one, viz., that of the reduction of the natural product by means of metallic zinc to anthracene. The question therefore naturally suggested itself. What is the nature of the hydrocarbon formed by the same process fron anthraflavic acid? Is it anthracene or something else? In order to decide this question I took a quantity of the acid and heated it with 50 times its weight of zinc powder, in the manner described by Gräbe and Liebermann. I obtained a quantity of a brownish crystalline sublimate, amounting to about 10 per cent of the acid employed, which was purified by sublimation and washing with ether. It still retained the yellowish tinge which, according to Gräbe and Liebermann, adheres so pertinaciously to anthracene, but it did not differ in other respects from the pure substance. It melted at the same temperature as anthracene, and began to sublime before

fusing; it dissolved in boiling alcohol, but more readily in benzole, and was deposited from these solutions in lustrous crystals of a very regular form; and it gave, like anthracene with picric acid, a compound crystallising in long red needles. I wish to speak with some reserve on this point, as the quantity of material at my disposal was not sufficient for an analysis, but should it turn out that my product is identical with anthracene, this fact would throw doubt on some of the reasoning of Gräbe and Liebermann, who assume that if an organic substance yields a definite hydrocarbon by the action of metallic zinc, the latter contains the same number of atoms of carbon as the original substance.

ON THE

CHANGE EXPERIENCED BY METALLIC IRON AND BY IRON OXIDES WHICH HAVE SERVED TO DISSOCIATE CO.*

By I. LOWTHIAN BELL.

(Continued from p. 147).

Expt. 347.—After 4½ hours' exposure to a current of CO at a temperature of melting zinc, about 420° C. (788° F.), its composition was:—

Fe..	49·83
Oxygen by difference	0·07
Earths	48·67
Carbon	1·43 = 2·87 per 100 Fe.
	100·00

Expt. 348.—Three hours' exposure to CO at a red heat gave—

Fe:.	49·88
Oxygen by difference	0·20
Earths	48·68
Carbon	1·24 = 2·48 per 100 Fe.
	100·00

In experiments 245, *et seq.*, it was shown that when the proportion of CO_2 exceeded 50 volumes to 100 of CO, all carbon deposition was suspended when oxide of iron, in various ores, was exposed at different temperatures to such a mixture. The same law holds good when the iron contained in such ores has been previously reduced to the metallic condition by hydrogen, oxidation of the Fe taking place. This circumstance appears to prevent carbon impregnation.

Subject to all the precautions of excluding air, and avoiding other circumstances which could interfere with the results, the following trials were made with perfectly reduced Cleveland ore:—

	Mixture of gas. CO. vols.	CO_2. vols.	Time of exposure. hr.	Temp.	Carbon deposited.	Oxygen absorbed per 100 of Fe.
Expt. 349.	100	616	¼	melting zinc	*nil*	18·46
,, 350.	,,	98	½	,,	,,	—
,, 351.	,,	,,	½	bright red	,,	5·91
,, 352.	,,	61	13½	,,	,,	3·48
,, 353.	,,	57	7	,,	,,	5·14
,, 354.	,,	38	½	melting zinc	,,	1·31

The deposition of carbon from CO, as it is effected by metallic iron is, it has been proved, always accompanied by the simultaneous oxidation of a minute portion of the Fe; it remains to be considered, whether, when the metal is taken in its oxidised state, any carbon impregnation takes place before a minute quantity of iron is brought down to the condition of Fe, a state of things deemed indispensable, I believe, by previous writers. It is obvious, that if a mere absorption of O is required, a lower state of oxidation, passing into one of a higher description, may suffice, and thus iron, in its metallic form, may not be required.

To ascertain whether there was any metallic iron present, the iodine test, examined in experiment 51, *et seq.*, was employed, in which, it will be remembered that, although it was impracticable to distinguish whether iron, as hydrated FeO or Fe, is present in the substance in question, it was easy to say whether the metal in neither of these conditions existed; moreover, anhydrous protoxide was almost unaffected by iodine and cold water. Under these circumstances, then, we may speak confidently, that when iodine and cold water dissolves no iron, neither hydrous FeO nor Fe are present, and the anhydrous protoxide, if present, must be so in very small quantities:—

The following trials illustrate the change experienced by different oxides of iron, exposed simultaneously for seven hours in the lead bath, to the action of CO, zinc melting, but antimony not:—

Substance Used.	*Expt.* 355. Fe_2O_3 from $FeSO_4$.	*Expt.* 356. Precipitated Fe_2O_3.	*Expt.* 357. FeO from Nitrate.	*Expt.* 358. Pumice and Fe_2O_3.	*Expt.* 359 Calcd. Clev. ore.
Carbon	31·9	45·5	56·3	1·69	0·11
Fe, soluble in iodine ..	11·4	2·5	1·4	*nil.*	*nil.*
Fe, insoluble in iodine..	47·1	45·2	37·7	11·34	40·60
O by difference	9·6	6·8	4·6	3·71	15·75
Earthy matter	—	—	—	83·26	43·54
	100	100	100	100	100

Calculated upon 100 parts of metallic iron present, the above numbers yield:—

	Fe_2O_3 from Fe_2SO_4.	Precipitated Fe_2O_3.	Fe_2O_3 from Nitrate.	Fe_2O_3 Pumice stone.	Calcd. Clev. ore.
Fe soluble in iodine ..	19·5	5·3	3·7	—	—
Carbon	54·5	95·4	144·0	14·9	0·3
Oxygen	16·4	14·3	11·7	32·7	38·8
Per cent original O lost	61·7	66·6	72·4	23·6	3·2

These numbers show how materially the molecular state affects deoxidation and carbon deposition, and, at the same time, they prove that the extent of the latter is firstly independent of the presence of any metallic iron (*vide* experiment 358), and, secondly, that it bears, as usual, no ratio to the extent to which the oxygen has been removed, although in each of these cases where the loss of oxygen has been the largest, the carbon deposited is the highest.

The view of the deposition of carbon being effected without the necessary formation of any metallic iron, was also borne out by the following experiment:—

Expt. 360.—Well calcined Cleveland ironstone was exposed for 3½ hours to the action of CO, freed from any traces of free oxygen, and from carbonic acid by passing through strong alkaline pyrogallate solutions. The temperature was close on that of melting zinc, and the CO_2 produced, and C deposited, were estimated.

The ore lost .. .. .. 2·55 per cent of its weight.
CO_2 collected, equal to.. 13·00 of weight of ore.

Residual carbon, estimated by solution in HCl, collected in asbestos filter, and combustion with lead chromate = 0·90 per cent, or 2·3 per 100 of metallic iron present:

Hence, loss of weight	= 2·55 per cent.
Carbon deposited	= 0·90 ,,
Oxygen removed	= 3·45 ,,

* From the "Chemical Phenomena of Iron Smelting."

Again:—

Oxgyen, corresponding to 13·0 CO_2 collected = 4·72
Ditto associated with 0·9 C deposited = 1·20

Difference = oxygen removed .. = 3·52

The agreement between these determinations shows the experiment to be trustworthy. On solution of the residual substance in HCl, and titration with permanganate, a quantity of ferrous compound was found equivalent to 23·2 per cent of Fe, or 29·8 of FeO.

If the reduction had been from Fe_2O_3 to 2FeO, this amount of protoxide would have generated, by the removal of—

$\frac{16}{144} \times 29{\cdot}8 = 3{\cdot}31$ per cent of oxygen,

whilst, had metallic iron been formed to this extent, an amount of oxygen must have been removed equal to

$\frac{3x16}{144} \times 29{\cdot}8$, or 9·93 per cent of O.

The actual amount removed being close upon the former number, it appears that no appreciable quantity of metallic iron could have been produced.

In no instance, let it be remembered, was it found practicable to remove the whole of the oxygen contained in the iron oxide employed by pure CO at temperatures short of a dull red heat, after 12 or 14 hours' exposure, even when the carbon greatly exceeded the weight of iron present. The curious fact, however, was noticed, that when the greater part of the oxygen was removed, the amount of iron insoluble in iodine and cold water, after some hours' digestion, was considerably more than that corresponding to the formula FeO, thus apparently indicating the formation of some sub-oxide, in the way already described. The three varieties of pure Fe_2O_3 previously employed yielded the following results, the temperature being about that of melting zinc, or a little higher:—

Substance used:—Precipitated Fe_2O_3, anhydrous.	*Expt.* 361.	*Expt.* 362.	*Expt.* 363.	*Expt.* 364. Fe_2O_3 from $FeSO_4$.	*Expt.* 365.	*Expt.* 366. Fe_2O_3 from nitrate.	*Expt.* 367.
Time of exposure,	7½ hrs.	7 hrs.	10 hrs.	15 hrs.	7 hrs.	7 hrs.	7½ hrs.
Iron insol. in I. ..	33·1	45·2	51·20	28·0	47·1	37·7	45·9
Do. sol. „ ..	*nil.*	2·5	0·10	0·6	11·4	1·4	*nil.*
Carbon	58·7	45·5	35·85	64·4	31·9	56·3	46·1
Oxygen	8·2	6·8	12·85	7·0	9·6	4·6	8·0
	100·0	100·0	100·00	100·0	100·0	100·0	100·0
Oxygen remaining with 100 parts iron insoluble in iodine	24·8	15·0	25·1	25·0	20·4	12·2	17·4
Carbon per 100 of Fe present..	177·3	95·3	69·5	225·1	54·5	144·0	100·4

Theoretical oxygen for 100 of iron being for Fe_2O.. 14·3
FeO.. 28·6
Fe_2O_3.. 42·8

Similar results were obtained on exposing various ores of iron to the action of CO in the lead bath apparatus. In all cases, the ores were previously heated in a muffle, to secure complete dryness and peroxidation.

	Expt. 368.	*Expt.* 369.
Substance used—	Clev. calcd. ore.	Hæmatite Lancashire.
Time exposed—	7 hours.	7½ hours.

Temperature—Melting zinc in both cases.

Composition after exposure, as determined by analysis				
	Fe sol. in I,	*nil.*	..	0·20
	Fe insol. „	40·60	..	33·35
	Oxygen ..	15·75	..	9·05
	Carbon ..	0·11	..	22·10
	Earths ..	43·54	..	35·30
		100·00		100·00
Oxygen remaining with— 100 parts Fe insoluble in I		38·8		27·1

ALTERATIONS IN PHARMACOPŒIAL NOMENCLATURE NECESSITATED BY THE ADVANCEMENT OF CHEMISTRY.*

By Professor ATTFIELD.

In speaking of the present position of the chemical names of the *Pharmacopœia*, the author said—The system of nomenclature hitherto accepted from chemists by pharmacists, practitioners in medicine, and the public, that which is employed in European and American Pharmacopœias, was mainly devised by Lavoisier, eighty-four years ago. The fundamental principle on which it was founded was, that the name of a salt should express its composition. The many animal and vegetable substances discovered since that time (notably alkaloids and neutral crystalline principles) are designated, perhaps fortunately, by unsystematic names, names which, at all events, are not liable to change. The great majority of chemical substances employed in pharmacy are such mineral salts as were known to Lavoisier, and their names were given by him on the assumption that they contained, on the one hand, an undecomposable body, generally a metal, common to a great many such salts (the compounds of copper, for example), and, on the other, a body, or a group of elements, also common to a number of salts (sulphates, for example). Soda, potash, lime, baryta, magnesia, and alumina were then considered to be elements; hence, as I shall further show presently, such names as carbonate of soda, nitrate of potash, and sulphate of baryta were perfectly consistent with those of carbonate of iron, nitrate of mercury, sulphate of copper. During the twenty years succeeding 1787, Lavoisier's views of the constitution of salts and the language or nomenclature in which those views found expression, were generally accepted throughout Europe; up to 1807 no necessity arose for interfering with his nomenclature; but in that and the following year Davy made his brilliant researches on the alkalies and alkaline earths, discovered that potash, soda, baryta, strontia, and lime were not elements, as had been previously supposed, but that the true basylous radicals of the so-called compound of potash, soda, baryta, strontia, and lime were metals—to which were given the names potassium, sodium, barium, strontium, and calcium. Thenceforward the old names potash, soda, baryta, strontia, lime, were used to designate the oxides of the new metals. Then there at once arose a dilemma in regard to nomenclature. The names of all the salts of Davy's metals were no longer consistent with the names of the salts of all other metals. Davy, supported afterwards by Dulong, Clark, Graham, Liebig, and Daniell, suggested that *all* metallic salts were composed of metal alone on the basylous side, and a distinct radical on the acidulous side. Unfortunately, however, accurate knowledge of constitution was not included in this idea; even definite names being proposed for the said acidulous radicals. Thus blue vitriol was termed oxysulphionide of copper (Daniell), sulphatoxide of copper (Graham), and sulphanide of copper (Otto). Many other objections to the theory arose, and hence salts came to be regarded as compounds of oxides of metals with certain acidulous radicals (now known as anhydrides). But the followers of applied chemistry never took kindly to the nomenclature.

Hence, when a very few years ago chemists were led by irresistible arguments and stubborn facts to double many of the old atomic weights, an opportunity of abandoning the old constitutional theories then presented itself, and was by common consent accepted. The exertions of Dumas, Laurent, and Gerhardt bore fruit. The dualistic idea of salts being formed of an acidulous radical with the oxide of a metal, and the not less binary notion of their being composed of a distinct acidulous radical united with a metal, were abandoned, and hypothesis altogether

* Abstract of a paper read before the Pharmaceutical Society, April 5th, 1871.

rejected, or, at all events restricted to the idea of *oneness*. These views were, of course, accompanied by a commensurate alteration in chemical notation and nomenclature. Blue vitriol no longer being considered to be the sulphate of the oxide of copper, as shown in the formula CuO,SO_3, nor even to have the binary constitution implied in the formula Cu,SO_4, but to be a structure *per se*, or at least, one whose detail of constitution was unknown,—it became necessary to devise for it and all such salts a notation and nomenclature which should be consistent with the unitary idea. Strictly speaking, this was impossible. The relationship—nay, the absolute identity—of the constituent radicals in whole classes of salts demanded fair representation in notation and nomenclature, a result fatal to pure unitary ideas. Thus, the unquestioned relationship of the cupreous compounds to each other demanded the employment of the word "copper" in their names and the symbol Cu in their formulæ; while the unquestioned relationship of salts containing the elements which occur in the non-cupreous portion of blue vitrol demanded the employment of the word "sulphate" in their names and the symbols SO_4 in their formulæ, and with the employment of such names and such formulæ the binary idea is difficult to repress. At the same time all are agreed that the unqualified assumption of knowledge of chemical constitution involved in the old binary theories is wrong; hence professedly binary systems of notation and nomenclature must be abandoned; the names sulphate of oxide of copper, with its formula CuO,SO_3, and sulphate of oxide of magnesium (or sulphate of magnesia), with its formula MgO,SO_3, must be given up for sulphate of copper, $CuSO_4$ (or copper sulphate or cupric sulphate), and sulphate of magnesium, $MgSO_4$ (or magnesium sulphate). Such names and formulæ sufficiently exhibit unquestioned relationships, while they include the least possible amount of theory.

Chemical Notation.—All teachers of chemistry, including the authors of nearly every modern manual, with remarkable unanimity have relinquished the old system of notation, and have, to a greater or less extent, adopted the new. It is to be expected that the next British Pharmacopœia will employthe usual chemical symbols as expressive of the new atomic weights (O=16) to the exclusion of the old (O=8), and will altogether discard the hypothesis of the constitution of salts involved in such formulæ as KO,NO_5, or (accepting the new atomic weights) K_2O,N_2O_5, using only the less theoretical formulæ (*e.g.*, KNO_3) which are now employed by the majority of teachers.

The old system is given up by chemists; the new is already officially recognised by the Council, under whose authority the Pharmacopœia is issued, and by the various examining Boards, and is adopted in educational works on chemistry.

These are sufficient reasons for justifying us in the expectation of seeing the new notation, if any, alone employed in the third British Pharmacopœia. Notation and nomenclature should obviously harmonise, seeing that they are simply different methods of expressing the thoughts and wants of everybody respecting chemical substances. Formulæ are more comprehensive than names, and convey to the mind far more information, but they are intelligible only to the educated chemist. Names comprise less knowledge, but are more or less understood by everybody and suffice for general purposes. To formulæ, however, we look to ascertain the views of chemists concerning the constitution of chemical compounds, and it is on these views that nomenclature is founded.

Properties of Names.—The names of pharmacopœial chemicals should fulfil certain functions or possess definite qualities, positive or negative, namely,—

1. The name should, as far as possible and practicable, indicate composition. This Lavoisierian principle is, as I have already shown, one of necessity as well as expediency.

2. One name should be associated with only one substance; but the converse I would by no means urge, namely, that one substance should be known by only one name, synonyms being useful both from a theoretical and a practical point of view.

3. A name, even if fallen out of use, should not be transferred to a substance having properties different from the original substance.

4. The names of an official chemical substance, that is, a name officially recognised in national pharmacopœias, should possess the minimum of instability.

The free employment of Latin and Greek numerals in a chemical name, though highly useful in general chemical literature for indicating details of a composition, is too dependent on hypothesis respecting atomic values and weights, and too susceptible of disturbance caused by new discoveries, to possess the element of permanence; hence they must be avoided in pharmaceutical chemistry.

5. A pharmacopœial name should admit of being either easily spoken or written, both in the full and in the contracted form.

6. When close resemblance between two salts is indicated by identity in all but one of the syllables of their names, that syllable should be at the commencement of the names and not at the end, where it would be liable to be omitted. So green iodide of mercury and red iodide of mercury are better than mercurous iodide and mercuric iodide, or green sulphate of iron and persulphate of iron to ferrous sulphate and ferric sulphate; any greater precision that may be desired being given by chemical formulæ.

7. A name should not be changed for mere purpose of euphony, real or fancied; thus, chlorhydric for hydrochloric.

8. Names of pharmacopœial chemicals should be consistent with each other.

9. The chemical names employed in pharmacy should be consistent with those used in other branches of applied chemistry, and with the language of scientific chemistry and general chemical literature.

The Proposed Names.—The advantages claimed for the proposed names are that they are more consistent with each other than the old; they are formed on one uniform system instead of two; they include less of theory, and therefore have greater elements of stability than the old; and they are harmonious, whilst the old is absolutely inconsistent with both modern scientific nomenclature and the only chemical notation now employed. Their newness, so far as they are new, is their only disadvantage, and even this disadvantage is, in practice, reduced to insignificant proportions.

Resumé.—The chief alterations in pharmacopœial nomenclature now proposed amount to this, that the compounds of the alkali-metals and alkaline-earth-metals instead of being named as hitherto on two distinct systems, should follow but one; that instead of salts of potassium and of potash we should have salts of potassium only; and instead of sodium and soda compounds, sodium only; and so with preparations of ammonium, lithium, calcium, magnesium, and aluminium. This is a step in the direction of simplicity and permanency, and away from that of theory.

Synonyms.—Modern scientific chemical names and the old dualistic names should, I think, be included as synonyms of the leading name in all Pharmacopœias.

Exceptional Alterations.—Constitutional objections to the name *arsenicum acidum* would be obviated by the old name *arsenicum album*. In view of the peculiar composition of bichromate of potassium, the first word of its name is most unsuitable, and would be advantageously replaced by red chromate, a name which would usefully distinguish the salt from yellow chromate of potassium. The names of the bismuth powders are not at present consistent with each other; if the one be termed subnitrate the other should be subcarbonate, not "carbonate." But these preparations and the similar compounds of copper and lead are normal rather than "sub" salts, containing

oxygen in the place of an exactly equivalent quantity of the acidulous radical of the neutral salts, and might well be termed respectively oxycarbonate of bismuth, oxynitrate of bismuth, oxyacetate of copper, oxyacetate of lead; at all events the latter names would do good service as synonyms. Similar remarks apply to the peroxhydrates of iron. The prefix "sub" is most usefully, and, indeed, indispensably, applied in the case of calomel: it would be well if the meaning of the syllable could be always thus restricted to its etymological signification, and never again used in its old conventional sense. The names tartarated antimony, tartarated iron, tartarated sodium, I do not like at all. The sister terms sulphurated antimony and sulphurated potash are most happy, their utter vagueness fairly representing the nondescript character of the preparations. But tartrate of antimony and potassium, tartrate of iron and potassium, and tartrate of sodium and potassium, are at least as definite in composition as the citric trio which are properly honoured with the definite names citrate of bismuth and ammonium, citrate of iron and ammonium, and citrate of iron and quinia (or, rather, with the old forms of those names).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 30th, 1871.

Professor Williamson, F.R.S., President, in the Chair.

The President delivered the following address:—

Gentlemen,—I feel much pleasure in congratulating you on the rapidly increasing prosperity of our Society, and the enlargement which has taken place in its sphere of usefulness; for, on the one hand, the number of our Fellows continues to show a most satisfactory increase; and, on the other hand, your Council has made arrangements for carrying out the system of monthly reports, which has been for some time in contemplation. It was hoped that the Chemical Society of Paris might, from the first, co-operate with us in the preparation of these monthly reports, but circumstances beyond their control have prevented the sister Society from joining us in the beginning of this year. Deeming it undesirable to delay the commencement of the reports, your Council still look forward to the future co-operation of the Paris Society in their preparation.

You are aware that the present available income of the Society was not considered to be sufficient to defray the additional expense of writing and printing these reports; and I have the pleasure of informing you that contributions to the extent of £1175 have been promised by members of your body towards supplying the deficit during the first five years of the appearance of the reports. The British Association has, moreover, granted us the sum of £100 for this year in aid of the undertaking. We hope that in five years the funds of the Society may have sufficiently increased to enable us to pay the whole expense of the reports, and that their publication will be valued by the Members of our Society, and promote the advancement of our science wherever the English language is read. The next number of our journal, which I hope to see in a few days, will be the first to contain the monthly reports in addition to the original papers contributed to the Society.

The following papers have been read at our meetings since the last anniversary:—

"Analysis of Deep Sea Water." By John Hunter.
"On the Refraction Equivalents of the Aromatic Hydrocarbons and their Derivatives." By J. H. Gladstone.
"Note on Bromopicrin." By T. Bolas and C. E. Groves.
"On an Acid Feed-Water from the Coal-Field at Stellarton, N.S., and the Results of its Use." By Professor How.
"On Tetrabromide of Carbon." By T. Bolas and C. E. Groves.
"Chemical Researches on New or Rare Cornish Minerals." By A. H. Church.
"On the Combinations of Carbonic Anhydride with Ammonia and Water." By E. Divers.
"On a New Gas Furnace for Chemical Operations at a White Heat without the aid of a Blowing Machine." By C. Griffin.
"On Vapour Densities." By James T. Brown.
"Researches on Vanadium." Part II. By H. E. Roscoe.
"On the Precipitation of the Solutions of Ammonium Carbonate, Sodium Carbonate, by Calcium Chloride." By E. Divers.
"On the Manipulation of Assays of Gold and Silver Bullion." By C. Tookey.
"On some New Bromine Derivatives of Coumarin." By W. H. Perkin.
"On Organic Matter in Water." By C. Heisch.
"On the Methods for the Determination of Carbon in Steel." By W. D. Herman.
"On Fungi and Fermentation." By James Bell.
"On Acetic and Formic Acid obtained from Human Urine during the Chemical Decomposition of Urochrome." By J. L. W. Thudichum.
"On the Production of the Sulphates of the Alcohol Radicals from the Nitrites by the Action of Sulphurous Acid." By E. T. Chapman.
"On the Composition of the Hyposulphites." By E. A. Letts.
"Mineralogical Notices." By N. Story-Maskelyne and Walter Flight.
"On some Derivatives of Anthracene." By W. H. Perkin.
"On some New Derivatives of Coumarin." By W. H. Perkin.
"On the Action of Sulphuric Acid on the Natural Alkaloids." By Henry E. Armstrong.
"On an Alkaloid from Cinchona Bark, hitherto undescribed." By David Howard.
"On the Origin of Nitrates in Potable Waters." By Charles Elkin, Bath.
"On the Development of Fungi in Potable Waters." By E. Frankland.
"On the Effects of Pressure on the Absorption of Gases by Charcoal." By John Hunter.
"On the Solubility of Bone-Ash in Carbonic Water." By Robert Warington.
"On the Distillation and Boiling-Point of Glycerine." By Thomas Bolas.

The following lectures have also been delivered:—

"On Vanadium." By Dr. Roscoe.
"On the Platinum Ammonias." By Dr. Odling.
"On the Distillation of Wood." By Mr. Chapman.

At the last anniversary meeting, we numbered 551 ordinary Members and 36 foreign Members, and six of the former have withdrawn from the Society. On the other hand, 42 new Members have been elected into the Society. We have lost five ordinary Members by death—viz., Mr. George Jolley, Dr. W. A. Miller, Dr. Augustus Matthiessen, Dr. J. S. Muspratt, and Mr. W. W. Routh; and it is also my painful duty to record the death of two of our foreign Members—viz., Professor Gustav Magnus and Professor Weltzien.

William Allen Miller was born at Ipswich, in Suffolk, on the 17th of December, 1817. His early education was conducted by his mother, a lady of remarkable sagacity, good sense, and religious feeling. Those who had the privilege of her friendship could trace in her son many points of mind and manner in which he closely resembled her. Miller spent one year at Merchant Taylor's School, London, and two years at a school at Ackworth, in Yorkshire, belonging to the Society of Friends. Lectures on

elementary chemistry were given at this school, and hence he seems to have imbibed his taste for a science which was to form the business of his life. He also took great pleasure in studying the stars through a telescope which one of the masters used to exhibit to the pupils. The influence of these early studies may be traced through his life in his devotion to chemistry, and in his application of his knowledge to the chemistry of the stars. His mental training at Ackworth was valuable, and his manner became still more marked by that quiet simplicity which was a characteristic of his mother, as it is also of the members of the Society of Friends.

At the age of fifteen he was apprenticed to his uncle, who was surgeon to the General Hospital at Birmingham. Five years later, he became a student in the medical department of King's College, London. Here his chemical knowledge attracted the notice of Professor Daniell, who availed himself of his assistance in the laboratory during the illness of the appointed assistant. This was the turning-point in Miller's career, and gave a decided bias to his studies. In 1839, he gained the Warneford prize, for the encouragement of theological studies among medical students. In 1840, he visited Germany, and passed some time in Liebig's laboratory at Giessen. In the same year he was appointed to the post of Demonstrator in the laboratory of King's College. In 1841 he became Assistant Lecturer to Professor Daniell, and also took his degree of M.D. in the University of London. He likewise aided in various scientific inquiries, and conducted the experiments on the electrolysis of saline compounds, which Daniell was then carrying on. Their joint names appear in a paper on this subject published in the *Philosophical Transactions* for 1844.

In 1845, Miller was elected a Fellow of the Royal Society, and in the same year he was appointed to the chair of Chemistry in King's College, which had become vacant by the sudden death of Professor Daniell. In the same year, he laid before the British Association an account of some experiments on the action of certain gases on the solar spectrum. This paper appeared in the *Philosophical Magazine* (3rd series, vol. xxvii., p. 81.)

For some years after his appointment, Miller continued to use the work of his predecessor as a text-book for the chemical classes at King's College. His own work on chemistry was undertaken after considerable hesitation lest he should injure the reputation of his master, Professor Daniel. "You are not aware," he said to the writer of this notice, "how much of Daniell I have in my notes." For some time, his idea was to revise Daniell's "Introduction to the Study of Chemical Philosophy," and to make such additions as the progress of science required, and to maintain it in its old position as the text-book of the chemical classes. But, on looking over the work with this view, he found that so many additions and alterations would be required as greatly to supersede the author's peculiar touches. He therefore decided to produce a new work, and to leave "untouched that of his late master as the true exponent of his views upon some of those branches of science which his researches had contributed to advance and adorn." These words are from the preface to the first edition of Miller's "Chemical Physics," dated March, 1855. This volume, as well as the two subsequent ones on "Inorganic" and "Organic Chemistry," which appeared, the one in 1856, and the other in 1857, were written from Miller's lecture-notes, so that when the books were introduced, the students of King's College, far from having to conform to any new method, seemed to recognise in the new text-books the very lectures they had heard. The three volumes of Miller's "Elements of Chemistry," passed through several editions in the course of a few years. Being successful, they were reprinted, as a matter of course, in the United States of America, but we are informed that for the later editions some arrangement was made with an American publisher, whereby the author and his publisher derived some benefit from the sale of the work in the United States. In these later editions, Miller adopted the new method. His conservative principles led him to resist this change as long as it was possible to do so; but having been, during so many years, accustomed to the old notation, he never took kindly to the new. Indeed, it was part of Miller's character to grasp a new idea with a certain amount of mental slowness; but when once fairly appreciated, it was held tenaciously, and not given up without a severe struggle.

Miller was an excellent chemist, thorough in his work, and thorough in laboratory practice and teaching. His views, without being remarkable for originality, always fairly represented the science of the day, and were expressed with great clearness, in simple language. As a lecturer, he was more successful in style and expression than as a writer. With the pen in his hand, his style often became involved, and not fully expressive of his meaning. Feeling this, he was accustomed to submit his writings to an intimate friend on whose judgment and long experience in such matters he could rely.

Miller took a great interest in the progress of spectrum analysis, and in 1861 lectured on that subject at one of the evening meetings of the British Association for the advancement of science, at Manchester. It was expected that this lecture would consist, for the most part, of an account of Kirchhoff's researches; but, to the surprise of many, a large diagram was exhibited, arranged something like a genealogical tree, containing the names of the various discoverers and the points discovered up to the date of Kirchhoff's researches. This lecture was illustrated by a number of experiments, at that time as remarkable for their novelty as for their brilliancy. Few persons who heard that striking lecture delivered in that crowded music-hall were aware that the lecturer had been confined during the day by a severe bilious attack to his bed, from which he arose to deliver the lecture, and to which he returned immediately after its close.

At this meeting, he presided over the chemical section, and read a short paper on "Photographic Spectra of the Electric Light." The full account of his researches on this subject, based upon a very large number of experiments, was laid before the Royal Society, and is published in the *Transactions* for 1862, p. 861. These researches seem hardly to have received the attention they deserve.

"On the 15th of January, 1862, Miller repeated his lecture on "Spectrum Analysis" before the Pharmaceutical Society of London. This lecture was attended by his friend and neighbour, Mr. Huggins; and while returning home together Mr. Huggins proposed that Miller should join him in some experiments on the spectra of the heavenly bodies. The results of this joint inquiry were given to the Royal Society, and were rewarded by gold medals from the Astronomical Society. Miller also gave a course of four lectures "On the Spectra of the Heavenly Bodies" at the Royal Institution in Albemarle Street, in 1867.

He likewise delivered a lecture on the same subject to the working men of Exeter, at the meeting of the British Association in that city in 1869.

During many years Dr. Miller was one of the Assayers of the Mint and of the Bank of England. He also paid great attention to the subject of water analysis. It will be remembered by many present that in 1865 he gave us a lecture "On Some Points in the Analysis of Potable Waters." His latest work was the preparation of a thermometer adapted to deep sea soundings.

We all remember the tone of melancholy that was given to the last meeting of the British Association by the sudden illness of our friend, which soon terminated in his death. Although removed at the early age of fifty-three, he had passed a life which, measured by its results, cannot be called a short one. If we were asked to name, in one word, the most marked feature in Miller's character, we should say it was *sagacity*. Well acquainted with the scientific tendencies of the day, cautious in forming as well as expressing opinions, just in his dealings with others—

his advice and assistance were sought by persons in various stations, from a cabinet minister down to a humble inventor and patentee. His services were of great value to the Royal Society. He frequently served on the Council and on various Committees appointed by the society in its own interests and those of science, if the two can be separated. He became Treasurer of the Royal Society in 1861, and, as such, Vice-President. He was one of the original founders of the Chemical Society, and has frequently occupied this Chair as well as a place at our Council Board. He has, on several occasions, contributed to our Journal, but he was not often heard in debate. Indeed, he had a dislike to impromptu utterances from a feeling that, in the heat of debate, rash things are often said, and the cause of truth and fair dealing endangered. The caution of his character is here again conspicuous, together with his love of truth. These were based on a deep religious belief which formed the mainspring of this whole life.

Professor Miller received the degree of M.D. at the University of Edinburgh; that of D.C.L. at the University of Oxford in June, 1868; and that of LL.D, at the University of Cambridge in May, 1869, after giving the Reade Lecture. He was buried on the 5th of October last, in Norwood Cemetery, by the side of his wife, whom he survived one year.

I have to observe that the preceeding lines are from Mr. Tomlinson's pen.

Augustus Matthiessen, born January 2nd, 1831, was the son of a London merchant. While a child of two or three years old he had a paralytic seizure, from which he never entirely recovered. As a boy, his fondness for chemical experiments was strongly marked, and his wish was immediately on leaving school to devote himself to the study of chemistry; this, however, he was unable to do. While very young he lost both his parents, and his guardians did not consider themselves justified in sanctioning his devoting himself to physical science, or to his becoming a merchant, believing that the paralytic affection from which he suffered totally incapacitated him for both pursuits, and, believing that the only occupation open to him was farming, they sent him on leaving school to serve an apprenticeship to a large farmer in Dorsetshire. Although thus frustrated in his desire at once of devoting himself to the study of chemistry, it in no way altered his determination. During the three years which he passed at the farm, he devoted much of the time and money at his disposal to chemical experiments and, immediately on coming of age, he quitted the farm and went to Giessen as being the school where he could best carry out his desire of studying chemistry. Under the direction of Professor Will and of Professor Buff, he obtained a thorough knowledge of the elements of chemistry and physics, and, during his stay in Giessen, he took his degree of Doctor of Philosophy. From Giessen he went to Heidelberg, and, under Bunsen's direction, at once began the preparation of the metals of the alkalies and alkaline earths, and the study of their physical properties. Matthiessen's first paper was published in our journal for 1855.

He was the first to obtain the metals strontium and calcium, decomposing the chlorides by an electric current, and, further, he clearly showed that both potassium and sodium were incapable of effecting this decomposition. In the laboratory of Professor Kirchhoff, he carried on experiments on the physical properties of the metals, and, in 1857, published an account of his experiments on the electrical conductivity of sodium, magnesium, calcium, potassium, lithium, and strontium. In the following year he extended this series of researches, estimating the electrical conductivity of many other metals, metalloids, and some alloys. In 1857, Matthiessen returned to England, and, for a short time worked at the College of Chemistry, then under the direction of Dr. Hofmann. While there, he published a short account of the action of nitrous acid on aniline. He afterwards had a laboratory at his residence in Torrington Place, and worked there most assiduously for about four years. During this time he published several papers on the specific gravity of different metals and alloys, and also on the electrical conductivity of some alloys and metals, specially gold and copper. In conjunction with Professor G. C. Foster, he published his first paper on the organic alkaloids, establishing the composition of narcotine, and gaining considerable insight into its rational constitution. In the spring of 1861, he was elected a fellow of the Royal Society, and, in the following year became Lecturer on Chemistry at St. Mary's Hospital Medical School, a post which he held for six years. He was afterwards chosen Lecturer on Chemistry, at first in conjunction with Dr. Odling, at St. Bartholomew's Hospital, and afterwards, on Dr. Odling removing to the Royal Institution, Matthiessen became the sole lecturer on chemistry. While holding these chairs of chemistry, his interest in the science never flagged, and his indomitable love of work enabled him to accomplish much. His later published papers relate entirely to the organic bases—narcotine, morphia, codeia—they all yielded to him most interesting and important results, and he seemed on the eve of still more important discoveries. At St. Bartholomew's, a new laboratory had been built under his supervision, and he looked forward with pleasure to the increased facilities it would give him for carrying on his scientific reseaches; but this was not to be. The laboratory had been completed but a few days before his death. Interested in his work to the last, planning new researches, completing old ones, unfailing in his official duties towards his large class of students, carrying on a large consulting practice—all was managed with precision and regularity to the last. Under the strain which, without relaxation, had been put upon his brain for years, it apparently gave way, and on the 6th of October last he died by his own hand.

A man of singular acuteness, and wonderful intensity of purpose, what he undertook to do he accomplished, and did it well. The personal defects he had to contend against were what few could have overcome, but he was able with complete success to lecture to large audiences, and as a scientific chemist, he had reached the foremost rank. In 1869, the Royal Society awarded to him a Royal Medal, and, in 1870, he was chosen one of the examiners of chemistry at the University of London.

Karl Weltzien, the son of a Russian merchant, was born in St. Petersburg, but was removed, at the age of ten, to South Germany, on account of his delicate health. The family settled in Karlsruhe, and in 1831, Karl entered the University of Heidelberg, as a student of medicine, taking his degree of Doctor of Medicine in 1835. He was, however, led to this course of study rather by the love of natural science than by a desire to enter upon the practice of medicine; and accordingly he devoted himself especially to the study of chemistry, which he afterwards pursued further under Mitscherlich's direction in Berlin. On his return to Karlsruhe, he was made Extraordinary Professor of Chemistry at the Polytechnic Institute, and ten years later, on the reorganisation of the Polytechnic Institute, he was appointed Professor of Chemistry and President of the Chemical School. A new laboratory was at the same time fitted up under his direction. Here he worked happily as teacher and investigator for sixteen years, training many able students, who made important investigations under his direction; writing seven original works on chemical subjects, and performing a large number of original researches which were published in Liebig's *Annalens*. He was always ready to apply his scientific knowledge and skill to the general good, with which view he gave instruction in various technical applications of chemistry, and lectured for many years to the officers of the Artillery on those departments of the science which relate especially to their profession. He also gave great attention to the sanitary condition of the town, and analysed a large number of spring and well waters, with a view of obtaining an improved water supply. This last investigation led him to the discovery of a new method of esti-

mating nitric acid. In 1868, he resigned his Professorship in consequence of failing health, and the remainder of his life was a constant struggle with severe suffering, which he bore with great fortitude. He died on the 14th of November, 1870.

After the reading of the address, and the obituary notes, the Treasurer presented his account of the Society's finances, which shows a balance of £1333 1s. 3d. at the banker's. Of this sum, however, £220 8s. are subscriptions to the Special Fund for the monthly Reports.

The elections of the President, the Officers, and the ordinary Members of Council for the ensuing year then took place, and the following are the names of the gentlemen elected:—

President—E. Frankland, D.C.L., F.R.S.

Vice-Presidents, who have filled the office of President—Sir B. C. Brodie, F.R.S.; Warren De la Rue, Ph.D., F.R.S.; A. W. Hofmann, D.C.L., F.R.S.; Lyon Playfair, Ph. D., C.B., F.R.S.; A. W. Williamson, Ph.D., F.R.S.; Col. P. Yorke, F.R.S.

Vice-Presidents—H. Debus, Ph.D., F.R.S.: J. H. Gilbert, Ph.D., F.R.S.; H. M. Noad, Ph.D., F.R.S.; W. Odling, M.B., F.R.S.; T. Redwood, Ph.D.; J. Stenhouse, Ph. D., F.R.S.

Secretaries—A. Vernon Harcourt, M.A., F.R.S.; W. H. Perkin, F.R.S.

Foreign-Secretary—H. Müller, Ph.D., F.R.S.

Treasurer—F. A. Abel, F.R.S.

Members of Council—E. Atkinson, Ph.D.; H. Bassett; C. L. Bloxam; A. Dupré, Ph.D.; F. Field, F.R.S.; M. Holzmann, Ph.D.; H. McLeod; E. J. Mills, D.Sc.; H. E. Roscoe, Ph.D., F.R.S.; W. J. Russell, Ph.D.; R. Angus Smith, Ph.D., F.R.S.; A. Voelcker, Ph.D., F.R.S.

The Scrutators were Messrs. Spiller and Armstrong.

The customary votes of thanks to the President, the Secretaries, the Treasurer, &c., brought the anniversary proceedings to a close.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

March 21st, 1871.

E. W. BINNEY, F.R.S., F.G.S., President, in the Chair.

Mr. John Hopkinson, D.Sc., was elected an Ordinary Member of the Society.

"*On the Mechanical Equivalence of Heat*," by the Rev. H. HIGHTON, M.A.

The following is an abstract of the arguments as given in the paper and brought out in the subsequent discussion.

(1). The author apologised for having mentioned other names in connection with great discoveries which were undoubtedly due primarily to Dr. Joule, and spoke of the very great value of Dr. Joule's experiments, even when he did not agree with the deductions drawn from them.

(2). The subject is of extreme importance both for the interpretation of physical phenomena and for determining what limits are assigned by the stern laws of Nature to the exercise of man's mechanical and scientific skill.

(3). No doubt Dr. Joule has ascertained the heat ordinarily derived from the destruction of energy, by means of friction with various substances, but it has been assumed, *im defiance of facts*, that the numerical relations which connect heat and energy in the case of friction hold good when energy and heat produce or destroy each other by any other means.

(4). In the case of friction itself, energy is not transformed simply into heat, but partly into heat and partly into another kind of energy, which is involved in the expansion of the solids or liquids acted on.

(5). No doubt the coincidence between the mechanica equivalent of heat, found by Dr. Joule from friction, and that by M. Favre from working a magnetic engine, seems very striking; but

(*a*). The value of Favre's experiment disappears on examination. It was but a single experiment, either never repeated, or never repeated with the same results; in a very delicate experiment there was only the difference of 300 units out of 18,000; and even the permanent enlargement which always takes place in magnets which are in use might account for these; and

(*b*). Numerous and long-continued experiments by M. Soret show results entirely discordant with the single one of M. Favre.

(6). It seems incredible, that with the imperfectly constructed engine used by Joule and Scoresby, they should at the very first trial have succeeded in utilising two-thirds of the magnetism evolved, or capable of being evolved, by their battery; and Dr. Joule now tells us that according to his latest calculations of the mechanical equivalence of heat, they utilised six-sevenths of the power of the battery. The only conclusion we can arrive at is, that the real power of the battery, and therefore of a grain of zinc, must have been much greater than he calculated.

(7). For consider the disadvantages under which the engine acted.

(*a*). The temporary and permanent magnets were never nearer than quarter of an inch apart. Though Dr. Joule assures us this does not affect the *power* of the engine, it certainly produces a waste of zinc, as the near approach of the magnets creates counter-currents which check materially the consumption of zinc.

(*b*). The copper wire was not tested for conductivity; a subject little thought of at that time, and it is found that a very small impurity in copper wire will very, very largely diminish the power of an electro-magnet.

(*c*). The iron was not tested for specific capacity for magnetism; yet this is a most important point which is even now but little appreciated. It is found practically that, if two electro-magnets be made from the very same piece of iron, most carefully prepared, with the very same length of the same wire, without the slightest assignable cause, one will sometimes have three times the power of the other. Hence I conclude that the maximum energy capable of being evolved by a grain of zinc must be very much greater than that assigned to it by Dr. Joule.

(7). Dr. Hopkinson's argument, in his paper lately read to this Society, virtually amounted to this—that a well-constructed magnetic engine will get no more duty from a grain of zinc than an ill-constructed one; and consequently, I presume, that magnets might be weakened to any extent, and removed to ever so great a distance from one another, without necessarily affecting the efficiency of the engine.

(8). Dr. Hopkinson has in his criticism strangely substituted $(a-b)$ for (b). In Joule and Scoresby's paper, the consumption of zinc is expressed not by $(a-b)$ but by (b); and consequently the duty of a grain of zinc not by

$$\frac{W}{a-b} \text{ but by } \frac{W}{b}$$

and when the magnets are stronger and approach nearer to each other, even if W be not increased, (b) is diminished.

(9). My argument was this, that since the accepted theory of the mechanical equivalence of heat is *that production of energy absorbs, and destruction of energy produces, a definite amount of heat*, if we find cases, as those of elastic wires, and water below its maximum density, in which destruction of energy produces cold, not heat, then the doctrine of the mechanical equivalence of heat cannot be true; we might with equal justice call it a mechanical equivalence of cold. It is no reply to say that such facts are simple deductions from the laws of thermodynamics. This would only show that the laws of thermodynamics are inconsistent with the doctrine of the mechanical equivalence of heat.

(10). The argument from the fire syringe I withdraw, as inconclusive. But I think my case was sufficiently established without it.

(11). Joule and Scoresby in their paper incorrectly assume that if the quantities of electricity in the current at different times be represented by (*a*) and (*b*), the heat varies as a^2 to b^2. This is only true where the resistance is the same. In the cases before us the working of the engine introduces a fresh element in resistance.

(12). Again, by assuming that (*a*—*b*) represents diminution of quantity of the current, *and* the diminution in the zinc consumed, *and* the heat converted into useful work, they involve the supposition either that less zinc produced equal heat, or that heat was changed into useful work which was never produced at all, and, therefore, could not be absorbed. In fact, there was no *proof* that any heat was absorbed at all.

(13). It is said that in electro-plating, electro-magnetic engines, worked by steam, are found more economical than batteries. This is in cases where a battery of many cells would be required, which is always wasteful, as a large number of equivalents of zinc must be consumed to deposit one equivalent of silver or other metal.

(14). Besides, there is a far greater advantage in changing work into electricity than electricity into work. In the former case all, or nearly all, the work is effective; in the latter, a very small portion of the electricity has hitherto been utilised.

Dr. HOPKINSON said that most of Mr. Highton's objections to the mechanical equivalent of heat appear to arise from a mistake as to what is meant by the term. The nature of this mistake may be best seen in the case of a perfect heat engine, of which t_1 and t_0 are the absolute temperatures of the source and refrigerator. Then from every unit of heat leaving the source we obtain

$$\frac{t_1 - t_0}{t_1} J$$

units of work. Now this a quantity variable with t_1 and t_0; it would be similar to most of Mr. Highton's arguments to infer that from a given quantity of heat a variable quantity of work could be obtained. But, of course, the case really is, that, of the unit of heat leaving the source $\frac{t_0}{t_1}$ is lost in the refrigerator, whilst $\frac{t_1 - t_0}{t_1}$ disappears *as heat* and is converted into the work done, and the principle of the equivalence of heat and work asserts that J is constant. It will be seen that this is the mistake Mr. Highton makes in his paper in the *Quarterly Journal of Science* (end of article 6). He seems there to imagine it stated, that the work done is equivalent to the whole heat thrown into the gas, and he fails to perceive that a certain portion is used to raised the temperature of the air or turpentine.

This will make my criticism of his subject in the CHEMICAL NEWS clearer. Mr. Highton argued against the mechanical equivalent, and what I pointed out was, that the chemical energy, which was converted into mechanical effect and *not* used to heat the wire, was proportional to $a-b$, that, therefore, in order to prove that there was no mechanical equivalent, Mr. Highton must show $\frac{W}{a-b}$ is variable. I do not assert that a badly constructed engine will get as much heat from fuel as a good one, but merely that the work done and the heat, which has disappeared as heat and been converted into work, are in a constant ratio.

Now as regards Mr. Highton's argument from the case of elastic wires—that the wire will be cooled when stretched—follows from the two laws of thermodynamics; a proof may be seen in Tait's "Thermodynamics," p. 105. Mr. Highton replies, "Quite true; but this only shows that one of the laws of thermodynamics is inconsistent with the doctrine of the mechanical equivalence of heat." Now the first law of thermodynamics asserts nothing else than that there is a mechanical equivalent, constant in all cases; whilst the second law as usually stated involves the first law, and involves nothing else but Carnot's axiom and the principle that in conduction heat flows from the hot to the cold body, both of which no one will doubt. Mr. Highton's reply is very similar to stating that one of Kepler's laws is inconsistent with the planets moving in ellipses. What Mr. Highton proposes as a paradox is then a necessary consequence of the principle he attacks.

Though the doctrine of the mechanical equivalent of heat finds its firmest basis in the immortal experiments of Dr. Joule, the fact, that assuming it we can explain many phenomena, is a valuable supplementary proof.

"*Examples of the Performance of the Electro-Magnetic Engine*," by J. P. JOULE, D.C.L., F.R.S., &c. (Next week).

NOTICES OF BOOKS.

First Annual Report of the Deputy Master of the Mint, 1870. Presented to both Houses of Parliament by command of Her Majesty. London: Eyre and Spottiswoode, 1871.

THIS volume contains, in about 130 pages, a large amount of interesting and valuable information. The report is divided into the following three parts:—Historical Account of the Coinage and the Mint; Consideration of the Principles of Minting and Regulations of the Mint; Proceedings of the Mint during the year 1870, and Changes of Establishment, &c., recently made.

To the report is added an appendix, from which we abstract the following portions of the memoranda and reports from the able hand of Mr. Roberts, Chemist to the Mint:—Most of our readers are aware that gold, even when mixed with very minute quantities of either lead, antimony, arsenic, or bismuth, becomes what is technically called "brittle," that is to say, it breaks so readily, under even a slight blow, as to become unfit for undergoing the various mechanical operations of converting it into coin. It appears from a long correspondence between the authorities of the Bank of England and bullion importers, as well as between the former and the Mint officers, that brittle gold is of far more common occurrence than even scientific men would be at first sight led to believe. While various modes of remedying this defect have been now and then proposed, it appears that the process, first suggested and successfully applied by Mr. Miller, of the branch Mint at Sydney, has, after a series of trials and experiments at the hands of Mr. Roberts, proved the best remedy for this evil. The loss of gold while in molten state, under the action of chlorine gas, is very trifling indeed, while the result of the operation (lasting only for four minutes, with a quantity of over 300 ozs. troy), even upon gold containing 0·05 per cent of antimony and 0·05 of arsenic, was perfectly successful; as was also an experiment upon a bar of gold containing 1·5 per cent of base metals, viz.—antimony, 0·3; lead, 0·2; zinc, 0·2; iron, 0·2; tin, 0·2; arsenic, 0·3; bismuth, 0·1. The gold, treated with chlorine, was found to be perfectly tough, and in every respect suited for undergoing the necessary operations of coining.

Mr. Roberts's memorandum on Assaying, illustrated by engravings, is an excellent monograph on this subject. It is divided into the following sections:—Assaying as an operation of Minting; Gold Assaying; Silver Assaying; Method of Reporting the results of Assays; Degree of Accuracy attainable; Assaying as a means of Account. From this section we quote the following interesting particulars:—Analysis of the assay reports (composition) on coins taken from half-a-million of gold pieces issued by the Mint in 1870.—The mean composition was, per mille = 916·617 gold, and 83·383 copper. That this result is in the highest degree satisfactory, and a proof of the high perfection of workmanship—aided by sound science—attained at the Mint, our readers may judge

from the fact that gold coins would be within the remedy of fineness prescribed by law, if the amount of precious metal they contained varied per mille from 914·6 to 918·6; while the coins issued by the Mint exhibit scarcely any divergence from the standard 916·6. The importance of maintaining the true standard composition of the coins is clearly shown by the fact that a variation of *one-tenth of a millième* above or below the standard represents a gain or loss to the department of nearly £100 on every million sterling issued.

The monograph above-named further contains a chapter on trial plates, and on the adjustment of blanks. The whole report and appendix bear strong evidence that on the part of the officers of the Mint, everything is done to bring that establishment to the highest possible efficiency. Combined with proper economy, and aided by scientific as well as engineering and mechanical skill, the Royal Mint may justly take rank as the first among these establishments in Europe.

CORRESPONDENCE.

CONCENTRATION OF SULPHURIC ACID.

To the Editor of the Chemical News.

SIR,—I have not observed any process by which sulphuric acid may be evaporated at a lower temperature than the boiling point of the liquid, and I wish to draw the attention of manufacturers of this acid to the following process which I have successfully tried.

The acid is heated in a lead pan in the usual way, and when it has reached a temperature of 300° F., a current of atmospheric air is blown through it, keeping it up to this temperature by the fire under the lead vessel.

By this means brown vitriol of 1·700 can easily be made without raising the temperature much above 300° F., and concentrated vitriol may also be made in a leaden pan by the same means at a temperature of 500° or so F.—I am, &c.,

JAMES STODDART.

Uphall Mineral Oil Works, N.B.
March 27, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus des Séances de l'Académie des Sciences, November 28, 1870.

Use to be made of Osseine as Food.—E. Fremy.—This very lengthy and exhaustive memoir contains the following sections:—On the difference existing between gelatine and osseine, and on the nutritive value and properties of the latter; preparation of osseine from bones; boiling of osseine, and the modifications it thereby undergoes; aromatisation of the osseine so as to render it more palatable and digestible. This memoir gave rise to a very lengthy discussion, here reproduced verbatim, in which M. J. Dumas, Dr. Liouville, and the author of the paper just mentioned took part. The gist of this discussion is, whether the osseine is really different from gelatine as food.

New Odoriferous Acid, the Product of the Fermentation of several Nitrogenous Matters, and particularly so of Tendons.—E. Chevreul.—The author says that, as far back as the year 1820, he had observed that the fermentation of some animal substances, especially the tendons, and parts used for making glue, produces a peculiar acid, which predominates over the ammonia, also formed by the fermentation (putrid) here alluded to. The acid in question is analagous to that which the author discovered in suint, and termed paraphocenic acid, both belonging to the class of volatile fatty acids. The bad smell given off by glue and size is due to this acid, which is also formed in the water wherein, in anatomical laboratories and dissecting rooms, parts of corpses are macerated.

Gas to be Used Instead of Coal-Gas for Filling Air-Balloons. H. Hureau de Villeneuve.—The author proposes the use of gas from wood, but, as observed by M. J. Dumas, this gas always contains a large proportion of oxide of carbon, which, as instanced by the trials made with wood-gas, caused asphyxia to the aëronaut, Dupuis-Delcourt. Moreover, even under the extraordinarily exceptional conditions Paris was placed in, there was no lack of coals for producing the gas necessary for filling air balloons.

New Arrangement of Galvanic Batteries, applicable also to the kind known as Bunsen's.—J. C. d'Almeida.—The advantages of the arrangement here alluded to, and described at great length, are stated to consist in—(1) The rapidity of getting the cells in working order, so that sixty cells are put in activity in the same time it now takes to arrange one in order; (2) economy in the use of acids; (3) transportability of the battery without any risk of breakage.

December 5, 1870.

Nutritive Properties of the Organic Substances met with in Bones, and on the Composition of the Alimentary Rations capable of Sustaining the Human Body in a Proper State of Health.—Dr. Milne Edwards.—This lengthy memoir contains, *in resumé*, a review of the labours of D'Arcet, Magendie, Dupuytren, and others on the subject mentioned.

Observations on some portions of M. Fremy's Paper "On the Use of Osseine as Food."—E. Chevreul.

Experimental Researches on the Nutritive Properties of Coca Leaves.—Ch. Gazeau.—A lengthy memoir detailing some experiments made with the leaves of the *Erythroxylon coca*, a well-known shrub, native of South America, the leaves being chewed like tobacco.

Specific Heat of Gases under Constant Volume.—J. Moutier.—An algebraico-physical essay.

Preparation of Osseine and Gelatine.—A. Riche.

Refining and Purifying of the Crude Tallow of Commerce.—J. Castelhaz.—The author proposes the use of weak alkaline solutions instead of the method and means now employed for this purpose. From the discussions to which the reading of this paper gave rise, it appears that this plan was adopted long ago, and is described in M. Payen's well-known work "Chemie Industrielle," vol. ii., p. 771.

December 12, 1870.

This number contains the following original papers and memoirs bearing upon chemistry and allied sciences:—

Hippophagy: Fat, Alimentary Oils, and Gelatinous Substances Obtainable from the Tissues and Bones of Horses and Cattle.—A. Payen.

Decemdiurnal or Tridodecuple Period of the Atmospherical Phenomena, and the Influence thereof on Health and Disease.—Ch. Sainte-Claire Deville.—This very lengthy essay on applied meteorology is illustrated by several diagrams.

Algebraical Formula for the Velocity of Sound.—J. Moutier.

Introduction of the Swine as Domesticated Animals by the Ancient Egyptians.—F. Lenormant.

December 19, 1870.

This number opens with the first portion of an historical *resumé* and essay on—

Gelatine, and the Investigations and Labours this Substance has been the Object of.—E. Chevreul.

This number further contains the following papers relating to chemico-physical and collateral sciences:—

Process Employed by the Tribe of Flat-Headed Indians to Extract Oil from the Long Bones of Animals.—Dr. Roulin.

Physical Geography: The Seine; Studies on the Quantity of Rain; on the Sources and Feeders of that River, and Application of that Knowledge to Engineering and Agriculture.—J. Belgrand.—This very lengthy memoir is, as indicated by the heading, chiefly of local interest.

Thermo-Dynamics: Force Exerted by Explosive Substances.—A. Cazin.—An algebraico-physical essay.

Study on the Volcanic Gases of Santorin.—Dr. Fouque.—From the contents of this lengthy memoir, it appears that the gases emitted by volcanoes vary very greatly in composition; that the pasty lava carries along with it combustible and other gases occluded in the pasty mass; that free hydrogen and marsh gas prevail and are more abundant as the temperature at which the lava escapes is higher; lastly, that hydrogen and oxygen co-exist in these gas mixtures without combining together, a result due in all probability to the extremely high temperature, being sufficient to keep the vapour of water dissociated.

Process of Panification whereby the Whole Grain of Wheat is Employed along with Flour.—M. Dubrunfaut.—The author proposes to steep the wheat in water to soften it; next, to crush it, by means of machinery akin to the well-known linseed crushers; and then to use the material along with flour in making bread.

December 26, 1870.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Continuation of the Memoir on Gelatine, &c.—E. Chevreul.

Researches on the Solid State of Bodies.—J. Moutier.—An essay on the state of aggregation.

Eclipse of the Sun of December 22nd, 1870: Measurement of the Variation of Light.—C. Flammarion.

Various Methods of Preserving Meat without the Use of Salt.—L. Soubeiran.

Mode of Solidification of Our Globe.—S. Meunier.—From researches made on meteorites, the author comes to the conclusion that the solidification of our globe has proceeded from the surface to the centre.

Bulletin de l'Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 1, 1871.

This number opens with the programme of the questions proposed by the Academy for essays on the following subjects relating to chemistry and collateral sciences. The complete study and investigation of an organic alkaloid containing oxygen and nitrogen, preferably quinine; in order to elucidate the intimate constitution of that body, and the place to be assigned to it in a seriary classification. The complete discussion is demanded on the question of the temperature of space (of the universe), to be based upon experiments and calculation, and with explanation on the motives, in reference to the different temperatures attributed to space. The composition of the plutonic rocks, or such as are so viewed, which are met with in Belgium and French Ardenne. The value of the medal to be given as prize for approved answers to the first and second questions here quoted will be £40, and for the other £24. Answers, written in Latin, French, or Flemish, should be forwarded, carriage paid, to M. A. Quetelet, perpetual secretary of the Academy at Brussels, before June 1, 1871.

This number further contains two short notices on the—

Aurora Borealis observed in Belgium from September to December, 1870—And on the—

Eclipses of the Sun, December 22nd, 1870, and of the Moon, January 6th, 1871, as observed at Brussels—By M. A. Quetelet.

Fossil Reptiles found in Belgium.—P. J. van Beneden.—A catalogical review of this subject.

NOTES AND QUERIES.

Distillation of Wood.—In the Chemical News, vol. xxiii., p. 91, was commenced a very interesting account of the distillation of wood, by Mr. E. T. Chapman. I believe that a great many of your readers would be highly interested to read the further particulars of this paper. —W. Hofmann.

Welding Steel and Iron.—(Reply to W. A. Murray.)—No such process can be given, as the white heat required for welding iron to iron would "burn" or decarbonise the steel; for instance, the making of the so-called cold chisels from cast-steel requires great care in regulating the heat of the forge, so as to prevent the steel breaking off while being hammered out on the anvil.—A.

Terra Alba.—In November, 1869, I had occasion to make some enquiries about terra alba, which were answered by a party signing his name as "Nemo" in the Chemical News (vol. xx., p. 252), and in which he stated that, if "Selenite" would send his address to him, he would send him a pamphlet on the subject. I would be glad to have the address of "Nemo" also, and I may be able to communicate some valuable information to him in relation to the subject of terra alba. —John Manning, Windsor, Nova Scotia, Dominion of Canada.

MEETINGS FOR THE WEEK.

Tuesday, 11th.—Photographic, 8.
—— Civil Engineers, 8.
Wednesday, 12th.—Society of Arts, 8.
Friday, 14th.—Astronomical, 8.
—— Quekett Microscopical Club, 8.
Saturday, 15th.—Quekett Club. Excursion to Barnes; to meet at Waterloo Station (Richmond Line) at 2 p.m.

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THE CHEMICAL NEWS.

Vol. XXIII. No. 594.

ON AMMONIUM AND THE SOLUBILITY OF METALS WITHOUT CHEMICAL ACTION.*

By CHARLES A. SEELY.

In April and May last it came in my way to make a pretty careful study of the constitution of the so-called ammonium amalgam, and on May 9th, I reported to the Lyceum of Natural History of New York what I had done in the matter up to that time. Subsequently, I continued the study, and was led to the discovery of the solubility of the alkali metals in anhydrous ammonia, an account of which formed a paper read at the Troy meeting of the American Association for the Advancement of Science. Neither of these communications have been printed; the first was oral, and the latter was lost. The present paper is intended to be a concise and authoritative statement of the contents of the two papers and as a substitute for them.

In the Lyceum communication I proved that the so-called ammonium amalgam is in fact no amalgam at all, but a metallic froth of which the liquid part is mercury and the gaseous part a mixture of hydrogen and ammonia. This conception of the nature of the substance was at that time not altogether novel, but the considerations through which the conclusion was reached were believed to be new and of such moment that, taken together, they have the effect of a demonstration. The considerations were these:—

1st. In the formation of ammonium amalgam the mercury is increased in bulk tenfold or more, while in weight it is increased only one or two thousandths. This fact would be easily predicted by the froth theory, while otherwise it is anomalous and utterly inexplicable.

2nd. Ammonium amalgam has less of the mirror surface than mercury; it approaches in appearance the whiteness and lack of lustre of matt silver. This fact also finds a satisfactory explanation in the froth theory.

3rd. Ammonium amalgam is readily compressible; when confined in a fire syringe it steadily contracts on forcing down the piston till the original bulk of the mercury is almost reached, and on relieving the pressure the original volume and appearance are resumed. It is only a froth which behaves in this manner.

Either (1) or (3) will be conclusive to many minds; (3) is put forward as a fair *experimentum crucis*. The condensation by pressure is easy to execute, and an elegant experiment for the lecture-room. The condensation is somewhat greater than in the case of atmospheric air, for the reason that some of the ammonia gas goes into the liquid state.

Having concluded that the ammonium amalgam is a mercuric froth, a very important question presents itself: Why and how do metal and gases become mingled? A froth is a mechanical mixture, and in all ordinary cases the manner of mixing and the forces engaged are quite evident. In the formation of the mercuric froth, the mercury covered by a watery solution rises up spontaneously into the comparatively light water, and the still lighter gases descend into the mercury and mingle with it until they become diffused through its whole mass. What are the forces which thus overpower the action of gravity? Moreover, a froth implies a certain viscosity or plasticity of the liquid which seems not to be possessed by the mercury in its normal condition. Do hydrogen and ammonia in their nascent state have the power to modify the physical properties of mercury? The production of mercuric froth as a fact of physics simply may seem anomalous and paradoxical. Is it necessary after all to admit the existence of an ammonium amalgam, not of course as a constituent of the mercuric froth, but as a condition precedent of the formation of the latter,—in other words, of another ammonium amalgam to satisfy a new thory?

I was making satisfactory progress in the investigation of the theory of mercuric froth when, early in May, my attention was diverted to the researches of Weyl on ammonium and compound ammoniums as reported in Watts's "Dictionary" (article, Sodium), and in the last edition of Fownes's "Chemistry;" subsequently, I compared Weyl's original memoirs in Poggendorff's *Annalen*, of 1864. Weyl's statements and conclusions were quite at variance with my own views; his alleged facts were inconsistent with my own experience. Weyl, it appeared, had actually isolated ammonium; if he represented the facts correctly all my work needed revision. I therefore at once devoted my whole care to a verification of his results. I repeated his experiments, some of them many times, and with such precautions, modifications, and additions as the case seemed to require. The result of all is that I find that Weyl has had only an imperfect apprehension of the fundamental facts, and that thus building on a weak foundation the superstructure of reasoning and conclusion cannot stand. For the purpose of presenting in a clearer light what I suppose to be of more interest to the chemical world, I dismiss, for the time, the consideration of Weyl's views, and I proceed to give what in my judgment are the proved physical and chemical facts.

This discussion involves the relation of ammonia to the alkali metals, and the results which grow out of that relation. Now, the key to the whole subject is the fact that liquid anhydrous ammonia is a solvent, without definite chemical action, of the alkali metals. I mean that these metals dissolve in the ammonia as salt dissolves in water,—the solid disappears in the liquid, and on evaporating the liquid, the solid reappears in its original form and character. There is no definite atomic action in any such cases; the components of the solution are not changed in their chemical relations to other substances.

I began my experiments by bringing together ammonia and the metals in sealed inverted U-shaped glass tubes. Chloride of silver saturated with ammonia was placed in one leg of the tube, and the metal under test in the other; the chloride of silver leg being immersed in boiling water, and the other in ice-cold water, the ammonia was liberated and passing over was gradually condensed on the metal. Snch an arrangement, although sufficient to demonstrate the fact of the solution of the metal, proved inconvenient in several respects; the tube is liable to burst, the experiment can be made only on a pretty small scale, the chloride of silver does not absorb a desirable amount of ammonia, and by reason of its fusing or agglomerating, the rapidity of its absorption varies greatly. I therefore constructed an ammonia generator or retort of iron, to the horizontal neck of which turned downward at its end, I attached by means of an iron screw coupling the stout glass tube containing the metal or other substance to be subjected to the ammonia. In the place of the chloride of silver I substituted anhydrous chloride of calcium saturated at 32° F. with anhydrous ammonium. With this arrangement the experiments were continued with comparative ease and expedition.

When sodium is subjected in this apparatus to the condensing ammonia, before any ammonia is visibly condensed to the liquid state, it gradually loses its lustre, becomes of a dark hue, and increases in bulk. The solid then appears to become pasty, and at last we have only a homogeneous mobile liquid. During the liquefaction, and for a little time after, the mass is of a lustrous, copper-red hue; the condensation of the ammonia and its mingling with the

* From advance-sheets of the *Journal of the Franklin Institute*. Communicated by the Editors.

liquid steadily goes on, the liquid is progressively diluted, and passing through a variety of tints by reflected light at last it becomes plainly transparent and of a lively blue as well by reflected as by transmitted light; the liquid now closely resembles a solution of aniline blue or other pure blue dye-stuff. On reversing the process by cooling the ammonia generator, the ammonia gradually evaporates out of the liquid, and the changes observed during the condensation reappear in the reverse order, till at last the sodium is restored to its original bright metallic state. If the evaporation be conducted slowly and quietly the sodium is left in crystals of the forms seen in snow. The formation of the transparent blue liquid, and the restoration of the sodium are steadily progressive, and the repeated and closest scrutiny of the process has failed to reveal the slightest break or irregularity in its continuity. The inevitable conclusion from such facts is that the blue liquid is a simple solution of sodium in ammonia, not at all complicated or modified by any definite chemical action.

If crystallised sodium amalgam be made to replace the sodium in the experiment, it remains unchanged, although it is probable enough that at a higher temperature or with a larger excess of sodium, some of the sodium would be removed. This interesting fact is consistent with the simple solubility of sodium in ammonia, and indeed is some confirmation of it. The force, whatever it be, which keeps together sodium and mercury is certainly weaker than that exhibited between sodium and ammonia. If sodium amalgam is not a definite chemical compound, then surely the blue liquid cannot be. I have not yet made the experiment to determine whether mercury will remove sodium from its ammoniacal solution, but it seems extremely probable that it would so act.

The brilliant and varied colours exhibited in the experiment may seem anomalous to some, when, in fact, a closer scrutiny of the case will show that they might have been predicted. Sodium appears white to the eye, but with the white light reflected from its surface to the eye, there are always mingled red rays. If most of the incident white light were normally decomposed, sodium would appear as a brilliant red metal. Ammonia favours such a decomposition probably by reducing the density and opacity of the surface, and thus the concentrated solution of sodium is lustrous copper-red by reflected light. What should be the colour by transmitted light? Not red, for the red rays do not penetrate the substance; the colour must be looked for in that which is complementary to red; it must be blue or yellow, or combinations of these. A continuance of the argument will bring the conclusion that the colour by transmitted light will be blue. Intense blue tinctorial substance like aniline blue, indigo, and Prussian blue, all illustrate the phenomena of colour of the sodium solution; they are metallic red when concentrated, and if the solvent be applied in vapour as in the sodium dissolving experiment, there will be the same modification of colour exhibited. Sodium has a remarkable tinctorial power which seems not to be surpassed by that of any of the aniline colours.*

If a salt of a metal electrically negative to sodium be subjected with the sodium to the ammonia, in the apparatus, the sodium will replace the negative metal, and the latter will be reduced to the simple state. This reduction seems always to be accompanied with the evolution of heat, but does not commence till a visible quantity of the sodium solution is formed. It is possible that there may be exceptions to these generalisations. I need only say that they seem extremely reasonable, and are confirmed by a good many experiments. The reaction furnishes a very simple and elegant process for the reduction of rare metals. I anticipate that the process will prove of great value.

* For a further elucidation of the matter of this paragraph, I would refer the reader to my paper on the "Colours of Metals," printed in the proceedings of the Lyceum of Natural History of New York, October, 1870.

I have heretofore spoken of the solution of sodium only, for the reason that it is a typical case, and because demonstrations can be more satisfactorily made with it. Potassium behaves towards ammonia in almost precisely the same way. It is readily dissolved, the strong solution being copper-red and the diluted solution blue. Lithium gives also a blue solution, but is not nearly so soluble. The only other alkali metal I have tried is rubidium, and although the experiment was prematurely ended, it had progressed far enough to make it almost certain that rubidium is soluble like potassium, and I intend, as soon as I can procure material, to repeat the rubidium experiment.

Besides the metals named, I have subjected many others to the ammonia, and have found none outside of the alkali metals which are in the least affected. I have directly tried aluminium, magnesium, thallium, indium, mercury and copper.

Chemical Laboratory, 26, Pine Street, N. Y.

ON THE CORONA SEEN IN TOTAL ECLIPSES OF THE SUN.

By Professor W A. NORTON.

IN a communication to the *American Journal of Science and Arts*, of September, I alluded briefly to the auroral theory of the solar corona, and referred to publications in which I had advocated to it. I propose now to give a brief discussion of the theory.

The grounds upon which I have maintained the auroral origin of the corona in different publications are the following:—

(1). the corona cannot be the permanent atmosphere of the sun, shining by reflected light, since its outline is neither circular nor oval, but exceedingly irregular, and it extends out from the sun many times farther in some directions than in others. The utmost that can reasonably be maintained is that for a small portion of its outward extent, for which the gradation of light is nearly uniform, it may possibly be a solar atmosphere.

(2). The natural indications of the aspect of the corona are that it is chiefly composed of separate masses of luminous matter, of unequal brightness and length, radiating out from different points of the sun's limb. The general radiated structure of the corona, and the great comparative outward extent, of the luminous radiations in certain directions, have attracted the attention of the observers of all modern eclipses. Some streamers have been seen to extend more than 1,000,000 miles from the sun, while others did not extend to one quarter of this distance.

(3). Reasoning analogically from the earth to the sun we naturally conceive the body of the sun to be surrounded by a permanent atmosphere. On the same grounds we should infer that the space exterior to this atmosphere is pervaded, either occasionally or permanently, by auroral streamers, similar to those which at times shoot out many hundreds of miles into space, from the upper atmosphere of the earth.

(4). If the luminous radiations of the corona are in fact auroral streamers, we must expect that they will not be permanent in their extent and position. Now it is well known that such is the fact, for the aspect of the corona has been very different in different eclipses (*e.g.* eclipses of 1842, 1851, 1858, and 1860). It has even been maintained by some observers that the rays of the corona had a flickering lustre, and varied in extent and position during the short period of a single eclipse.

(5). Admitting, as we must, the actual radiated structure of the corona, its individual streamers, or luminous radiations, may be conceived either to be permanently connected with the sun, or to be composed of luminous

matter actually streaming away from the sun, to an indefinite distance, into space. If we adopt the former idea, we virtually admit that a permanent vaporous atmosphere of sensible density extends from the body of the sun to a distance greater than to sun's diameter, a position that cannot with any plausibility be maintained.* In support of the other hypothesis we have the well-established fact that some form of luminous matter belonging to cometary bodies, when it comes under a certain degree of influence from the sun, is projected or in some manner detached from the nuclei of these bodies, and repelled from the sun, and under the operation of the solar repulsion urged away from them to an indefinite distance, forming the luminous trains by which they are attended. (See the author's papers on Donati's Comet published in *the American Journal of Science*, January and May, 1860, and July, 1861; and the discussion of the Dynamical Condition of the Head of a Comet in the No. for January, 1859).

To suppose that the rays of the corona are actual radiations of luminous matter, is only to suppose that a portion of the photospheric matter of the sun becomes subject to the operation of the same forces, that we perceive the sun to exert upon a portion of the matter of comets. The luminosity of such radiations may be ascribed either to a reflection of the sun's light or to electric discharges. Upon this question we shall see important evidence was obtained at the total eclipse of August 7, 1869.

(6). If we adopt the auroral theory of the corona, and at the same time admit that the auroral streamers are actual emanations of luminous matter, the following consequences may be expected to follow:—

(*a*). A portion of the auroral matter emitted from the sun should fall upon the earth's atmosphere, and may furnish the substance of terrestrial auroras, for which no terrestrial origin has yet been detected.

(*b*). Upon this view of the possible origin of terrestrial auroras, the close correspondence that has been detected between the periods of the sun's spots and of auroras, should subsist if we allow that the spots are merely the natural result of the supposed discharges of the solar matter, prevailing for a time at certain points of the photosphere; or, indeed, if we grant that they are in any way the result of these discharges visible in the corona.

(*c*). In the wave propagation of the impulsive actions on the ether of space, of the electric discharges to which we may ascribe the material emanations from the photosphere, and in the electric and magnetic phenomena attendant upon the reception and accumulation of the solar auroral matter in our atmosphere, we have a plausible general explanation of the periodic and irregular disturbances of the magnetic condition of the earth, and of their known physical relations to the sun's spots. This theory of the origin of the diverse perturbations of terrestrial magnetism I have elaborated, and followed out into a detailed discussion of the variations of the different magnetic elements in former numbers of the *American Journal of Science and Arts* (viz., for March and July, 1855).

We may add that it derives additional support from the general result arrived at by Professor Chambers, in his discussion of the "Nature of the Sun's Magnetic Action," viz., that "the mode in which forces originating in the sun influence the magnetic condition of the earth, is not analogous to the action of a magnet upon a mass of soft iron placed at a great distance from it, but that these forces proceed from the sun in a form different from that of magnetic force, and are converted into this latter form of force probably by their action upon the matter of the earth or its atmosphere." If this be admitted, then we must conclude that the perturbations of the earth's magnetic condition, as evinced by the variations of the position and directive force of the magnetic needle, must result either from some action direct or indirect on the earth or its atmosphere, of some form of matter emitted from the sun, or from a wave-action propagated from the sun, or from both of these operative causes combined.

(*d*). The streamers of the corona should have at different points of the sun's photospheric surface different directions, parallel to the diverse directions of the magnetic force of the sun at this surface. These directions should be variously inclined, in different heliographic latitudes, to the horizontal lines at the points of the surface, and also to the plane of the sun's equator; like the dipping needle on the earth and the streamers of a terrestrial aurora. In low latitudes the angles of inclination to the plane of the equator should be large, and the streamers proceeding from corresponding points in the two hemispheres should converge and intersect in the plane of the equator. In proportion as these corresponding streamers proceed from points more remote from the sun's equator, they will intersect under a smaller angle, and their point of intersection will be more distant from the sun's surface; until at the heliographic latitude of 30° to 35°, they will become parallel to the plane of the equator. Those emanating from still higher latitudes will diverge from the plane of the equator and from each other.*

If these facts be attentively considered it will be seen that the result should be the formation of a luminous appearance extending indefinitely outward from the sun into space, and elongated in the plane of his equator; and that to observers on the earth it would have an apparent form more or less triangular.

The same fundamental conception which accounts for the solar corona, and the physical relations known to subsist between the sun's spots and terrestrial auroras, as well as between these spots and the varied magnetic disturbances occurring on the earth, furnishes then an adequate explanation of the extent, form, and position of the *Zodiacal light*. In fact, we see that the zodiacal light is but the indefinite extension of the corona.

We have here tacitly supposed that the solar emanations consist of magnetic matter projected with great velocity into space, in the directions of the prolongations of the auroral columns, and proceeding on indefinitely in these directions; but if, like the cometic matter, they are exposed to a continual repulsion from the sun, the paths described by the receding particles would be hyperbolas convex toward the sun. The point of intersection of any two streamers proceeding from corresponding low latitudes in the two hemispheres, would in consequence be thrown to a greater distance from the sun, but the general result as to the form and position of the luminous appearance produced (the zodiacal light) would be the same.

In support of this view of the origin of the zodiacal light, we may state that Cassini drew from his observations on the sun's spots and the zodiacal light, made during the interval from 1665 to 1688, the conclusion that a physical connection subsisted between these two phenomena, and that the substance of the zodiacal light was, in fact, some emanation from the sun's spots. Again, according to Arago, it appears from the entire series of observations at Paris and Geneva, that the zodiacal light varies considerably from one year to another, and that the observed variations cannot result entirely from changes in the transparency of the atmosphere. We shall soon see that the form of the corona, as seen in the eclipse of 1869, and previous eclipses, presented certain prominent features that accord with the theoretical conclusion that the zodiacal light is but the indefinite extension of the corona.

It is proper to state here, that in what precedes we have really been contemplating but different sides of one comprehensive theory, which embraces a connected series of solar phenomena, of which the corona is but one term.

* According to the recent spectroscopic determinations of Lockyer and Frankland, the solar atmosphere, must be of exceeding tenuity in the region of the rose-coloured protuberances just above the general surface of the chromosphere.

* It is here assumed that the magnetic equator of the sun is coincident with his heliographic equator.

The outline of this theory is given in the author's "Treatise on Astronomy," revised edition (1867). It is that a portion of the matter of the sun's photosphere is in the habitual condition of auroral magnetic columns; that by electric discharges along these columns, their substance becomes dispersed and in part projected into space; and that this process, wherever occurring, may by a continued dissipation of a portion of the photospheric matter at that locality, eventuate in the formation of a visible spot on the disc; that the photospheric matter thus discharged into space is in that peculiar condition recognised in cometic matter in which it becomes subject to a repulsive action from the sun (or else to a diminished attractive action, as occurred to a certain extent in the case of Donati's comet, and in that of 1861), and in the act of flowing away is visible in solar eclipses as the streamers of the corona, and at more remote distances as the zodiacal light; that these solar emanations furnish the matter of terrestrial auroras, and when descending in copious showers into the earth's atmosphere, and developing electric currents and disturbing the magnetic condition of the earth, are the determining cause of all the phenomena of "magnetic storms." The apparent structure, and variability of the corona, and, as we shall soon see, the most characteristic features of its form, the form, position, and variability of the zodiacal light, the coincidence of the periods of the sun's spots with the periods of terrestrial auroras, and with those of the perturbations of the magnetic needle, all accord with this general theory. I have also endeavoured to show in my papers on the variations of the magnetic elements, that these variations are such as should naturally result from the electric currents in the upper atmosphere (or what may be called the photosphere of the earth), that would ensue from the reception of the supposed impulsive waves, and material emanations proceeding from the sun. (See *Am. Journ. Sci.*, II., vol. xix., March and July, 1855).

If it indeed be true, that from the fundamental conception of material emanations from the sun similar to those which we know to take place from the head of a comet under the influence of the sun, a connected series of phenomena may be theoretically deduced which have their actual counterparts in Nature, it must be conceded that there is a high probability that this conception is founded in truth, and furnishes the true explanation of the varied phenomena observed.—*American Journal of Science.*

EXAMPLES OF THE PERFORMANCE OF THE ELECTRO-MAGNETIC ENGINE.*

By J. P. JOULE, D.C.L., F.R.S.

SOME experiments and conclusions I arrived at a quarter of a century ago having been recently criticised, I have thought it might be useful to place the subject of work in connection with electro-magnetism in a different and I hope clearer form than that in which I have hitherto placed it. The numbers given below are derived from recent experiments.

Suppose an electro-magnetic engine to be furnished with fixed permanent steel magnets, and a bar of iron made to revolve between the poles of the steel magnets by reversing the current in its coil of wire. Such an arrangement is, perhaps, the most efficient, as it is the most simple, form of the apparatus. In considering it, we will first suppose the battery to consist of five large Daniell's cells in series, so large that their resistance may be neglected. We will also suppose that the coil of wire on the revolving bar is made of a copper wire 389 feet long, and 1-16th of an inch diameter, or offering a resistance equal to one BA unit. Then, on connecting the terminals of this wire with the battery, and keeping the engine still, the current through the wire will be such as, with a horizontal force of earth's magnetism 3·678, would be able to deflect the small needle of a galvanometer furnished with a single circle of one foot diameter, to the angle of 54° 23′. Also this current going through the above wire for one hour will evolve heat that could raise 110·66 lbs. of water 1°, a quantity equal to 85,430 ft.-lbs. of work. In the meantime the zinc consumed in the battery will be 535·25 grains. Hence the work due to each grain of zinc is 159·6 ft.-lbs., and heat 0·20674 of a unit.

I. In the condition of the engine being kept still we have therefore, current being 1·396, as shown by a deflection of 54° 23′—

(1). Heat evolved per hour by the wire, 110·66 units.
(2). Consumption of zinc per hour, 535·25 grains.
(3). Heat due to 535·25 grains, 110·66 units.
(4). Therefore the work per hour will be $(110{\cdot}66 - 110{\cdot}66)\ 772 = 0$.
(5). And the work per grain of zinc will be $\frac{0}{535{\cdot}25} = 0$.

II. If the engine be now started and kept by a proper load to a velocity which reduces the current to $\frac{7}{8}$, or 0·9307, indicated by deflection 42° 57′, we shall have—

(1). Heat evolved per hour by the wire, $110{\cdot}66 \times \{\frac{7}{8}\}^2 = 49{\cdot}18$ units.
(2). Consumption of zinc per hour, $535{\cdot}25 \times \frac{7}{8} = 356{\cdot}83$ grains.
(3). Heat due to 356·83 grains, $110{\cdot}66 \times \frac{7}{8} = 73{\cdot}77$ units.
(4). Therefore the work per hour will be $(73{\cdot}77 - 49{\cdot}18)\ 772 = 18983$ ft.-lbs.
(5). And the work per grain of zinc will be $\frac{18983}{356{\cdot}83} = 53{\cdot}2$, or $\frac{7}{8}$ of the maximum.

III. If the load be lessened until the current is reduced to $\frac{1}{2}$ of the original amount, or to 0·698, we shall have—

(1). Heat evolved per hour by the wire $110{\cdot}66 \times (\frac{1}{2})^2 = 27{\cdot}665$ units.
(2). Consumption of zinc per hour, $535{\cdot}25 \times \frac{1}{2} = 267{\cdot}62$ grains.
(3). Heat due to 267·62 grains $110{\cdot}66 \times \frac{1}{2} = 55{\cdot}33$.
(4). Therefore the work per hour will be $(55{\cdot}33 - 27{\cdot}665)\ 772 = 21357$.
(5). And the work per grain of zinc will be $\frac{21357}{267{\cdot}62} = 79{\cdot}8$, or $\frac{1}{2}$ of the maximum duty.

IV. If the load be still further reduced and velocity increased so as to bring down the current to $\frac{1}{3}$ of what it was when the engine was still, or to 0·4653, shown by a deflection of the galvanometer of 24° 57′, we shall have—

(1). Heat evolved per hour by the wire $110{\cdot}66 \times (\frac{1}{3})^2 = 12{\cdot}294$ units.
(2). Consumption of zinc per hour, $535{\cdot}25 \times \frac{1}{3} = 178{\cdot}42$ grains.
(3). Heat due to 178·42 grains, $110{\cdot}66 \times \frac{1}{3} = 36{\cdot}89$ units.
(4). Therefore the work per hour will be $(36{\cdot}89 - 12{\cdot}294)\ 772 = 18988$ ft.-lbs.
(5). And the work per grain of zinc will be $\frac{18988}{178{\cdot}42} = 106{\cdot}4$, or $\frac{1}{2}$ of the maximum duty.

V. Remove the load still further until the velocity increases so much that the current is brought down to $\frac{1}{10}$th of its quantity when the engine is still. Then we shall have—

(1). Heat evolved per hour by the wire, $110{\cdot}66 \times (\frac{1}{10})^2 = 0{\cdot}011066$ of a unit.
(2). Consumption of zinc per hour, $535{\cdot}25 \times \frac{1}{10} = 5{\cdot}3525$ grains.
(3). Heat due to 5·3525 grains of zinc, $110{\cdot}66 \times \frac{1}{100} = 1{\cdot}1066$ units.
(4). Therefore the work per hour will be $(1{\cdot}1066 - 0{\cdot}011066)\ 772 = 845{\cdot}73$ ft.-lbs.

* Read before the Manchester Literary and Philosophical Society, March 21st, 1871.

(5). And the work per grain of zinc will be $\frac{845{\cdot}73}{5{\cdot}352} = 815$, or $\frac{96}{100}$ of the maximum duty.

When the velocity increases so that the current vanishes the duty = 159·6.

I. Let us now improve the engine by giving it a coil of four times the conductivity, which will be done by using a copper wire 389 feet long and $\frac{1}{4}$th of an inch diameter, the same battery being used as before. Then when the engine is kept still we shall have a current 1·396 × 4 = 5·584, shown by a deflection of 79° 51′. Then we shall have—

(1). Heat evolved per hour by the wire, 110·66 × 4^2 = 442·64 units.
(2). Consumption of zinc per hour 535·25 × 4 = 2141 grains.
(3). Heat due to 2141 grains, 442·64 units.
(4). Therefore the work per hour will be (442·64 − 442·64) 772 = 0.
(5). And the work per grain of zinc will be $\frac{0}{2141} = 0$.

II. Start the engine with such a load as shall reduce the current to $\frac{1}{2}$, or to 3·7227 (74° 58′), then we shall have—

(1). Heat evolved per hour by the wire, 442·64 × $(\frac{1}{2})^2$ = 196·73 units.
(2). Consumption of zinc per hour, 2141 × $\frac{1}{2}$ = 1427·3 grains.
(3). Heat due to 1427·3 grains, 442·64 × $\frac{1}{2}$ = 295·09 units.
(4). Therefore the work per hour will be (295·09 − 196·73) 772 = 75934.
(5). And the work per grain of zinc will be $\frac{75934}{1427{\cdot}3} = 53{\cdot}2$ or $\frac{1}{3}$ of the maximum duty.

III. Lesson the load so that the velocity of the engine is increased until the current is reduced to one-half its original amount, or 2·792 shown on the galvanometer by a deflection of 70° 18′. Then we shall have—

(1). Heat evolved per hour by the wire, 442·64 × $(\frac{1}{2})^2$ = 110·66 units.
(2). Consumption of zinc per hour, 2141 × $\frac{1}{2}$ = 1070·5 grains.
(3). Heat due to 1070·5 grains, 442·64 × $\frac{1}{2}$ = 221·32 units.
(4). Therefore the work per hour will be (221·32 − 110·66) 772 = 85430 ft.-lbs.
(5). And the work per grain of zinc will be $\frac{85429}{1070{\cdot}5} = 79{\cdot}8$, or $\frac{1}{2}$ the maximum duty.

IV. Let the load be further reduced until the velocity reduces the current to $\frac{1}{4}$, or to 1·8613 shown by a deflection of 61° 45′. Then we shall have—

(1). Heat evolved per hour by the wire, 442·64 × $(\frac{1}{4})^2$ = 49·182 units.
(2). Consumption of zinc per hour, 2141 × $\frac{1}{4}$ = 713·66 grains.
(3). Heat due to 713·66 grains of zinc, 442·64 × $\frac{1}{4}$ = 147·55 units.
(4). Therefore the work per hour will be (147·55 = 49·182) 772 = 75940 ft.-lbs.
(5). And the work per grain of zinc will be $\frac{75940}{713{\cdot}66} = 106{\cdot}4$, or $\frac{2}{3}$ of the maximum.

V. Let the load be still further reduced until, with the increased velocity, the current becomes reduced to $\frac{1}{100}$, or to 0·05584 showing a deflection of 3° 12′. Then we shall have—

(1). Heat evolved per hour by the wire, 442·64 × $(\frac{1}{100})^2$ = 0·044264 of a unit.
(2). Consumption of zinc per hour, 2141 × $\frac{1}{100}$ = 21·41 grains.
(3). Heat due to 21·41 grains of zinc, 442·64 × $\frac{1}{100}$ = 4·4264 units.
(4). Therefore the work per hour will be (4·4264 − 0·04426) 772 = 3383 ft.-lbs.
(5). And the work per grain of zinc will be $\frac{3383}{21{\cdot}41} = 158$, or $\frac{99}{100}$ of the maximum duty.

Now suppose that we still further improve our engine by making the stationary magnets twice as powerful. In this case all the figures will remain exactly the same as before, the only difference being that the engine will only require to go at half the velocity in order to reduce the current to the same fraction of its first quantity. The attraction will be doubled, but the velocity being halved no change will take place in the amount of work given out.

In all cases the maximum amount of work per hour is obtained when the engine is going at such a velocity as reduces the current to one-half of its amount when the engine is held stationary; and in this case the duty per grain of zinc is one-half of the theoretical maximum.

The same principles apply equally well when, instead of employing the machine as an engine evolving work, we do work on it by forcibly reversing the direction of its motion. Suppose, for instance, we urge it with this reverse velocity until the quantity of current is quadrupled or becomes 22·336 indicated by a deflection of 87° 26′. Then we shall have—

(1). Heat evolved per hour by the wire, 442·64 × 4^2 = 7082·2 units.
(2). Consumption of zinc per hour, 2141 × 4 = 8564 grains.
(3). Heat due to 8564 grains of zinc, 442·64 × 4 = 1770·56 units.
(4). Therefore the work per hour will be (1770·56 − 7082·2) 772 = − 4100432 ft.-lbs.
(5). And the work per grain of zinc will be $\frac{-4100432}{8564} = -478{\cdot}8$ or − three times the maximum working duty.

The principal reason why there has been greater scope for the improvement of the steam engine than for the electro-magnetic engine arises from the circumstance that in the formula $\frac{a-b}{a}$, applied to the steam engine by Thompson, in which a and b are the highest and lowest temperatures, these values are limited by practical difficulties. For a cannot be easily be taken above 459° + 374° = 833 from absolute zero, since that temperature gives 12·425 atmospheres of pressure, nor can b be readily taken at less than the atmospheric temperature or 459° + 60° = 519°. Also there is much difficulty in preventing the escape of heat; whereas the insulation of electricity presents no difficulty.

I had arrived at the theory of the electro-magnetic engine in 1840, in which year I published a paper in the fourth volume of "Sturgeon's Annals," demonstrating that there is "no variation in economy, whatever the arrangement of the conducting metal, or whatever the size of the battery." The experiments of that paper indicate 36 foot-lbs. as the maximum duty for a grain of zinc in a Wollaston battery. Multiplying this by four to bring it to the intensity of a Daniell's battery we obtain 144 foot-lbs. Here, as in the experiments in the paper on "Mechanical Powers of Electro-Magnetism, Steam, and Horses," the actual duty is less than the theoretic; which is owing partly to the pulsatory nature of the current, and partly also to induced currents giving out heat in the substance of the iron cores of the electro-magnets; although these last were obviated as far as possible by using annealed tubes with slits down their sides.

SPECTRUM ANALYSIS

IN ITS APPLICATION TO THE BESSEMER PROCESS FOR THE MANUFACTURE OF STEEL.*

By Professor ROSCOE, F.R.S.

IT not unfrequently happens that scientific discoveries, the results of which are apparently far removed from our everyday wants, and are apparently of purely theoretical interest, become all at once of practical value and importance. We chemists, who are occupied with investigating the properties of bodies, and preparing new ones, if we are not satisfied, as indeed we ought to be, with the study of science for its own sake, may say, at any rate, that we have another field of interest, inasmuch as a body which may be discovered to-day, and which for a time remains a chemical rarity, useful and seen only in the collections of the scientific chemists, may become an object of great pecuniary value as applied to the arts and manufactures, or may become, as in the case of chloroform, an alleviator of the suffering of mankind. I have this evening to bring before you an application of this kind, which, if it is not so important as many, yet I think we shall all admit is one of the greatest interest. It is the application of the newly-discovered principles of spectrum analysis to the steel manufacture. It would be presumptuous in me on this occasion, and before such an audience as I have the honour of addressing, to enter into details on the subject of the Bessemer process. Still less would it become me to extol, as I might otherwise do, the genius and the persevering energy of the discoverer of this process. I think, however, that you will all agree with me in this,—that whether we look at it from an economical point of view, or from a chemical point of view, or from a mechanical point of view, the Bessemer process is one which has not its equal, either in modern or in ancient metallurgy, and that it has called forth a new era which I think is now about to be accomplished in the manufacture of our most important metals, iron and steel.

It is, then, to the application of the scientific principles of spectrum analysis to the manufacture of steel by the Bessemer process that I have to draw your attention; and I will begin by pointing out to you, as shortly as I may be able, the chief principles which regulate this most interesting branch of science, and I will afterwards point out how these principles affect the particular process under examination.

In the first place, then, so long ago as the year 1675, Sir Isaac Newton discovered that white light is the compound, whereas coloured light is the simple, phenomenon. He took a triangular piece of glass called a prism, and allowed the light shining through a hole in a shutter to pass through it, and to be received on a screen, and he found that the white sun-light was split up into a many-coloured band, which we now know so well as the solar spectrum. He came to the conclusion that the light of the sun consists of rays differently refrangible. He then performed the reverse operation; the coloured band which he thus obtained by passing the sun-light through the prism he looked at by means of another prism placed in the same direction. The coloured rays were then brought again to a focus, through the prism, in his eye; all the differently coloured light was united again, and produced in his eye the impression of white light; and he saw, as it were, a round hole of white light at that point. Kirchhoff, to whom we are indebted for an immense amount of knowledge, and for the discovery of the composition of the sun's atmosphere, instead of using one prism, as Newton did, uses four prisms, and, instead of looking at the spectrum with the naked eye, he views it through a telescope; but the most important alteration since Newton's time was that, instead of allowing the light to pass through a round hole, as Newton did, and so forming a round beam, Kirchhoff, and many others before him, especially Fraünhofer and Wollaston, took a narrow line of light. They opened a very narrow slit, and allowed the light to fall through it, so that the line of white light fell upon the first prism, and was bent out of its course as it were, and thus resolved into its ultimate parts—resolved into all the differently coloured rays, beginning with red, and ending with violet.

Although I cannot show you the solar spectrum, I can show you what will answer our purpose. I will show you the spectrum of the white carbon points of the electric lamp, for we have an arrangement by which we can throw the beam of light through a set of prisms, and instead of receiving it as a white light upon the screen, we receive a beautifully coloured band of light, in which we pass from red through all the gradations of orange, yellow, green, and blue, into the most refrangible rays, violet. But when we come to examine sun-light, we find that the sun-light possesses certain characters which the light from these white-hot carbon points does not possess, and to that peculiarity of sun-light I would, for a moment, draw your attention. What I wish to call your attention to, is the presence of these dark lines which intersect the coloured riband. These dark lines are always found in the sun-light, and they have received the name of Fraünhofer's lines, because they were first properly mapped by the German optician, Fraünhofer.

These lines have, since Kirchhoff's discovery about ten years ago, assumed a very great amount of interest, inasmuch as that discovery depended on mapping carefully and observing the positions of these dark lines which occur in all sun-light, whether we take direct sun-light, or reflected sun-light, or planet light (which is, in fact, reflected sun-light), or moon-light. These lines become of the greatest importance, because it is by their presence that we are able to tell anything whatever about the composition of the solar atmosphere.

It is owing to the position of these dark lines in the sun's spectrum coinciding with that of certain bright lines produced by the metals, that we are able not only to discover the composition of the solar atmosphere, but, in a similar way, the composition of the atmosphere of the fixed stars which possess lines of a different character altogether.

Now let us examine in another way the beam of coloured light, and note the character and properties of the light in the different portions of the solar spectrum. Imagine that you have before you the solar spectrum intersected as it would be by fine dark lines. We shall find that the different portions of this coloured band possess very different properties. Those rays which produce the effect which we term heat are situated almost altogether at the red end, and even beyond the red portion of the spectrum, so that the maximum of heating effect is situated there. The maximum of luminous effect is more in the centre, and the heating rays gradually diminish until they sink to an almost inappreciable quantity at the blue end. But as we pass along from red, through the orange, green, and blue, we find that the rays begin to assume a different character; that is to say, they are capable of producing different kinds of action—different kinds of work. When we come into the blue rays we find that we have light which is capable of producing chemical action. This fact has been known for many years; hence it has been customary to divide rays of light into the heating, the luminous, and the chemically active rays; and it was at one time believed that there was a total distinction between these three different kinds of light, and that in a particular portion of the spectrum we could separate the heating rays from the light-giving rays, and the light-giving rays from the chemically active rays. Such, however, is not really the case. We have no more power of distinguishing between the chemically active rays and the luminous rays than we have of distinguishing between the yellow light

* A Lecture delivered before the Iron and Steel Institute, on Wednesday evening, March 29th, 1871.

and the green light. They simply differ in wave length and in power of refrangibility. But although we cannot separate out, from any given portion, the light-giving rays from the heating rays, or the chemically active rays from the light-giving rays, yet I can show you by a singularly beautiful experiment that the maximum heating effect is at the red end. If I cut away the whole of this light by means of a screen, and allow only rays which are less refrangible to pass through—that is to say, rays which to the ordinary human eye are invisible—then we shall have the maximum of heating effect. This I can show you by a simple experiment which I have arranged here. I have in this dark box an electric lamp connected with the battery with which we have been working; and in front of this box I have what Dr. Tyndall—(for this experiment is his)—very appropriately calls a "ray-filter." It is a solution which is so dark that it will let no rays of light through; but it lets through the rays of heat, so that I can actually in the focus of these dark rays inflame a piece of black paper in perfectly dark space. There; you see I have got the paper burning in the focus of the dark rays. I could in this way light a cigar if I happened to have one. You see, too, that I can set fire to some gunpowder by the same means. This, then, shows us that beyond the red portion of the spectrum the rays of heat predominate.

Now allow me to prove to you what we have at the other end of the spectrum, where we have, as I said before, the chemically active rays present. I have in my hand a little glass bulb which is filled with a mixture of chlorine and hydrogen gases. These gases have this very remarkable property—that when they are exposed to the chemically active rays they combine. If I were to throw this little bulb out into the daylight, it would explode before it fell to the ground in consequence of the hydrogen and chlorine combining together under the action of light, or under the action, rather, of a particular portion of the solar rays. The gases, combining, will form hydrochloric acid gas. I have here a little lantern which contains differently coloured glasses: one is blue, another is red, and another is yellow; and the glass of one side is colourless. I am going to expose this little bulb inside my lantern, first to light passing through the red glass, and then to light passing through the yellow glass. The faint light of the ordinary gas of the room does not explode my bulb. I must cover up that portion of the lantern which consists of white glass, otherwise I shall get an explosion of the bulb before I want it. At present I leave only the red side visible. Now I am going to produce a bright flash of light which will be violet light, and contain a large quantity of the chemically active rays; but these chemically active rays will be filtered off by the red glass, and will not produce any explosion of the bulb. [The experiment was performed.] Now I am going to do the very same thing again; but I will turn the blue side of the lantern to the light and produce another bright flash, and then you will hear an explosion produced by the combination of the gases in the bulb. [The experiment was performed accordingly.] There, you see, the explosion was sufficient to indicate what I want, and we have our bulb smashed into fine powder.

So much, then, for the general side of the question—the general arrangement of the rays of light in the solar spectrum, and for their general distribution.

Now I will show you what kind of material it is which gives us this bright coloured band, varying from red to violet. We shall throw on the screen here an image of the carbon poles which are giving us this light, and you will see that these are white-hot incandescent solid substances; and, if I had made the poles of any other solid body which I could heat white-hot without that substance giving off any vapour, I should find that I should produce the same effect, namely, the effect of a continuous spectrum. You see that we can separate these poles for a little distance, but I cannot separate them for any great distance. We have now focussed them, and you see the beautiful image of them. We can separate them to a little way without the electricity ceasing to pass. They are white-hot and ignited by the passage of the current. Now, if you observe them, you will see that there is an arc of light between the two. This arc of light consists of glowing gas. Glowing solids and glowing liquids all give off a continuous spectrum, whilst glowing gases give off a discontinuous spectrum; that is to say, glowing gases have the power of what we term *selective radiation* they have the power of giving off a certain kind of light. We will now place on these poles a small quantity of a metal which has recently been discovered—the metal thallium—and you will see that we shall be able to volatilise the thallium; and I will ask you to observe that when it is placed on the poles we shall have a very brilliant arc—an arc of ignited thallium vapour. Now here we have the thallium. Look at this glorious stream of green light! It is due to incandescent thallium in the form of gas, and I can separate the poles to a very great distance, you observe, and still get this bright green band following, as it were, and carrying the electricity; and in that act of carrying the electricity the thallium is converted into vapour and giving off this particular green light. Now, if we come to examine this light by means of a prism, as we will do in a moment, you will see that thallium gives a totally different spectrum from that of the glowing carbon poles. [The prism was applied.] Now, observe the green band. We observe here the green arc and the green band at the same moment. If we narrow the slit a little, we shall get a still more beautiful scene. Now the whole of this spectrum analysis depends upon the fact that glowing gases have this power of selective radiation—the power of giving off bright bands instead of continuous spectra. No other substance that we know of gives this same green light. I am obliged to throw this light on the screen by means of a rough sort of apparatus, as it is necessary to get an intense light to enable you to see it properly; but, if instead of that, I looked at the thallium spectrum with one of those beautiful spectroscopes which Mr. Browning has placed on the table, I should see this green line reduced to the finest dimensions—as fine as the finest spider's web. We know that no other body gives this green line in exactly the same position.

Now, in the same way, we may go through a large list of metals. The next spectrum which we will throw on the screen is that of the metal copper. We have the power here of volatilising the copper, and we shall observe the kind of light which the copper gives off. Here you see the bright green bands due to copper. No other substance that we know of gives these bright green lines, and these other violet lines which are less distinct, though not less characteristic of the metal copper. You will readily imagine what a wide field spectrum analysis covers, inasmuch as if, in any distant star or source of light, we observe these particular green bands, we infer with truth that that light is due to the vapour of glowing copper. Thus, if we were to see these bright lines in the sunlight, or in the light of any other star, we should come to the conclusion that that far distant luminary contained copper. I will next show you, just as an example, the spectrum of silver; and in this case I will use a silver pole. We shall find that the silver pole becomes molten at the top, and that then the silver boils and is converted into vapour, and we get the peculiar light which the silver emits; and you will again notice, even in this very rough way, that the light is different from the light of the copper. In fact, in this instance, we see the copper lines too, for there is a little copper left at the top of the poles. If we keep the poles far apart, we get scarcely any continuous spectrum at all. These are the lines due to the vapour of metallic silver. Now we will use brass, and here we shall have the lines both of copper and zinc visible. Here are the splendid lines due to those metals, for in an alloy such as brass we get indications of the presence of both metals. You will recognise the copper lines, and you will also see the splendid red lines due to zinc. You see that in this

way we can detect the presence in brass of both copper and zinc.

The delicacy of this reaction is something almost beyond belief. I have a table here which will give you an idea of the enormous delicacy of this method:—

Delicacy of the Spectrum Analytical Method.

1. *Soda.*—1-3,000,000th part of a milligrm., 1-180,000,000th part of a grain, of soda, can be easily detected. Soda is always present in the air. All bodies exposed to air show the yellow soda line. If a book be dusted near the flame the soda reaction will be seen.
2. *Lithia.*—1-100,000th part of a milligrm. of lithia, or 1-6,000,000th part of a grain, can be easily detected. Lithium was only known to occur in four minerals. It is now found, by spectrum analysis, to be one of the most widely distributed elements. It exists in almost all rocks, in (3 cubic inches) sea and river (Thames) water, in the ashes of most plants, in milk, human blood, and muscular tissue.
3. *Strontia.*—6-100,000th part of a milligramme, or 1-1,000,000th part of a grain, of strontia is easily detected, and has been shown to exist in very many limestones of various geological ages.
4. *Lime.*—6-100,000ths of a milligrm., or 1-1,000,000th of a grain, of lime can be easily detected.
5. *Cæsium.*—This new alkaline metal was discovered by Bunsen in the mineral waters of Baden, Durkheim. Its spectrum consists of two bright blue lines. Thirty tons of mineral water yielded 100 grains of cæsium.

We detect the 1-180,000,000th part of a grain of soda, for instance, and the 1-6,000,000th part of a grain of lithium. Some substances which were supposed to be very rare are now found almost everywhere, and by this process no fewer than four elementary bodies have been discovered—viz., rubidium and cæsium, the new alkaline metals discovered by Bunsen; thallium, which was discovered by Mr. Crookes; and indium, which has also lately been discovered by some German chemists.

If we next take a mixture of the various alkaline salts, or of the alkaline earths, we shall get similar coloured bands. It is, however, by means especially of the electric spark that we can investigate these matters. I have here a means of producing a very bright spark, which is due to the passage of electricity between two brass points; and if I were now to look at this bright spark with a delicate apparatus such as is on the table, I should see exactly the lines which I have just very roughly shown to you on the screen; but, instead of seeing only a few lines, I should see many hundreds, the apparatus being more delicate, and the light being thrown directly into the eye. It thus becomes possible to map, with great accuracy, the lines of the different metals; and this was Kirchhoff's great business. He not only mapped the dark lines in the sun, but he also mapped the bright lines of the metals; and it was in this way that he found that every one of the bright lines of certain metals coincided with certain dark lines in the sun. This coincidence was found in the case of iron to the extent of many hundred lines. This observation showed that there was some connection between the bright iron lines produced by the electric spark and some of the dark lines which exist in every form of sunlight. How the lines which are due to iron become black in the sun, instead of being bright, I have not now time to explain. I will now throw on the screen the spectrum of a mixture of the salts of the alkalies and the alkaline earths, to give you an idea of the splendid parti-coloured riband of light which we thus obtain. Here are the spectra of potassium, sodium, lithium, barium, strontium, and calcium.

But it is not merely with the metals that we have to do in spectrum analysis: we have to deal with every form of matter, and therefore we have to deal with gaseous materials. You perceive, therefore, that we have to investigate the question as to what is the nature of the light which gases emit; I mean bodies which are gaseous at the ordinary temperature. I will show you how we can make use of electricity for the purpose of igniting the gases. I have here, for instance, a series of gases—hydrogen, carbonic acid, nitrogen, chlorine, and iodine—and these are contained in very minute quantities sealed up in a glass tube, so that the pressure within the interior of the tube is very nearly that of a vacuum, and yet the tube contains a trace of each of these materials. If we pass a current through the tube, we shall see that each gas glows with a peculiar light of its own. Here the hydrogen has a red tint, the iodine a green, and the chlorine a light blue colour; and when we come to examine these substances also by the spectroscope, we shall find that they emit a light of a perfectly peculiar character, and that just as well can we recognise hydrogen by its spectrum, when we get it in the state of ignition by means of the electric current, as we can recognise the spectra, as I have shown you, of the metals proper. I might show you, with tubes of other gases, the same principle—viz., that bodies of a gaseous character emit the light, or give off rays of the light which it is their peculiar property to emit. In this other tube you have nitrogen, with a most extraordinary striated mass of ignited rays; and beneath this you have the beautiful phenomenon of fluorescence caused by the presence of uranium glass in this tube. We can investigate the whole range of chemical elementary bodies in this way.

Here I will bring small quantities of substances into the flame. This body thallium has the power of tinging the flame. The splendid band now visible is due to the volatilisation of the metal of one of the alkaline earths. We can examine these bands not merely with the electric light, but, if we want to make the examination on a small scale, we make beads of the metals, and bring them into a flame. For instance, here I have a thallium salt, which you see tinges the flame green, giving off the peculiar green tint which is characteristic of thallium. Salts of the new metal, rubidium, have the power of volatilising and of tinging the flame of a splendid purple colour. This purple tint is characteristic only of the metal rubidium—that is to say, the lines which it gives off are peculiar to that metal. Here we have the violet light which is produced by potassium contained in the well-known substance, potash; and here, again, we have strontium, which gives a beautiful red light. We can readily obtain the spectra of most of these coloured flames.

(To be continued.)

ABSOLUTE TEMPERATURE.

By the Rev. H. HIGHTON, M.A.

1. The doctrine of the Mechanical Equivalence of Heat has involved the necessity of imagining an absolute zero of temperature—that is, a point below which cold cannot go, and at which there is an absolute deprivation of all heat.

2. This absolute zero is arrived at in the following way:—It is said that air for every degree of temperature loses $\frac{1}{274}$th part of the volume it had at the ordinary freezing point of water; and, therefore, that at the temperature $-274°$, it will cease to have any volume at all, or, as it is more euphoniously expressed, in order to avoid the obvious absurdity, it would cease to have any elastic force. Hence, it is gravely assumed in our fashionable modern books of science, that $-274°$ is the deprivation of all heat, and that the amount of absolute heat in a body is measured by its temperature above $-274°$. Thus it is proved that a pound of water at ordinary temperatures contains within itself heat capable of raising it at least 80 miles. Well may Tait, in his "Thermodynamics" (p. 21), call this one of the most extraordinary results of physical science!

3. But, unfortunately, if we take water as our standard, absolute zero would be totally different. Applying the same arguments to water, we might, if we reasoned from certain temperatures above the point of maximum density, make absolute zero of temperature about −2800°; and from others below the maximum density, the zero of cold beyond which heat could not be raised would be +6450°! Iron, mercury, and other bodies, would each give different zeros. The fact is, it is assumed that the same, or nearly the same, rule which applies to gases at some temperatures applies to them at all, and that they could never be liquefied.

4. To suppose an absolute zero of temperature appears to me as utterly absurd as to suppose that negative electricity could go on increasing in intensity till no positive electricity at all was left and there was an absolute zero of electricity. Heat, like electricity and motion, is relative, not absolute. It is positive, when it bears a certain relation to the state of things around it; negative, when it bears an opposite relation. Of absolute electricity we know nothing; but we assume, as our starting point, a state of equilibrium in neighbouring matter. So of motion; till we can find a point of absolute rest, we know only nothing of absolute, but only of relative motion. So in heat; our true starting point of zero can only be the average temperature of the universe, if ever that can be ascertained. Heat, motion, and electricity are all dual, not single forces; and it is from overlooking this duality of heat that all the modern errors on the subject have sprung. It is not so many years since, that when Mayer first propounded the theory of the Mechanical Equivalence of Heat, the opposition of the physicists of that day, and the difficulty he found in getting any scientific publication to print his views, actually drove him out of his senses. I can plainly see that the doctrine will be far more easily overthrown than it was established. I observe that your contemporary, the *Popular Science Review*, gives a verdict that my articles in the CHEMICAL NEWS have proved my point; and that the April number of the *Scientific Review* supports the case by an experiment of the simplest and most conclusive kind.

LABORATORY APPLIANCES.

By Professor LEEDS.*

New Form of Desiccator.—The desiccator in most common use, as is well known, consists of a low broad glass bottle, the outside of which is fitted by a ground glass joint to a glass cover. The inside is partly filled with fused calcic chloride, and the platinum crucible is supported either upon a glass tripod or upon a platinum triangle. It has the objection that the air in the interior expands when the hot crucible is introduced, and lifting the lid makes it escape. On cooling, a partial vacuum is sometimes produced which renders it difficult to remove the lid. To obviate this difficulty, a hole is frequently drilled in the cover. But in doing so it makes the ground glass joint of little benefit, and the apparatus thus arranged is little if any better than a bell-jar set upon a ground glass plate.

Schrötter's desiccator provides for the free egress of air in contact with the hot crucible. It consists of a bell glass placed upon a glass plate and containing the crucible. Through a hole in a cork fitted to the tubulure of the bell-jar a fine glass tube is passed to allow an escape of the heated air. This first tube is enclosed in a second tube, somewhat wider, closed at its upper end, and with holes drilled in the lower end, through which the air passes and bubbles up through sulphuric acid contained in the bottom of a third tube that includes the other two. The top of this outer tube terminates in a bulb opening upward, which is filled with calcic chloride. When a partial vacuum is produced in the interior, the air is made to pass through the sulphuric acid before re-entering and thus dried.

A more compact and convenient desiccator is represented in the woodcut. It consists of the base of an alcohol lamp, which is ground into the tubulure of a small bell-jar. The base is partly filled with sulphuric acid, and has a hole drilled in the side near the top to permit the egress of air. The bottom of the bell-jar is covered with fused calcic chloride and the top by a ground glass plate. One of the two discs which are used to exhibit the cohesion between polished glass surfaces answers nicely. Through the tubulure a funnel with a very large bulb is passed, its end dipping somewhat beneath the

surface of sulphuric acid. The platinum crucible is supported in the mouth of the funnel by a triangle. When the air is heated by the introduction of the crucible it bubbles up through the acid and makes its escape by the opening at the side. On cooling, the air forces the acid through the tube and partly fills the funnel, but as soon as the surface of the acid sinks below the end of the tube, air bubbles up through the long column of sulphuric acid until equilibrium is restored. The calcic chloride insures complete drying. It is hardly needful to say that the tube of the funnel is supported in the tubulure by an air-tight joint.

Water Air-Pump.—When the water air-pump is used in connection with a bell-jar and beaker, such as I have before described in the *Journal of the Franklin Institute*, a difficulty is encountered arising from the bursting of air-bubbles contained in the water, so soon as the latter finds itself in a vacuum. In order to obviate this difficulty a number of expedients were resorted to, the one figured in the woodcut proving most satisfactory. To the end of the funnel tube, which is passed through the tubulure of the bell-jar, a very small funnel is connected by a short piece of india-rubber tubing. The ends of the funnel tubes are ground so as to bring them as near as may be in contact. They may be fused, but this not only requires careful workmanship, but was found to be an arrangement very liable to accidents from the rigidity of the parts. The tube of the little funnel is bent in such a way as to bring one of its sides nearly vertical and parallel to the inside of the beaker against which it rests. When now the bubble expands it finds itself hemmed in by the walls of the funnel, and finally breaks quietly and trickles down the vertical side of the funnel until it comes into contact with the beaker.

The exhaust of the water air-pump with which I am working at present is somewhat more than 36 feet in length.

From advance-sheets of the *Journal of the Franklin Institute*. mmunicated by the Editors.

It is not unusual to have the barometric columns in the gauge rising to the height of 78 c.m., and to filter under a pressure of 65 c.m. When the vacuum is allowed to stand, the water supply being shut off, the water remaining in the exhaust tube is frequently lifted and runs back. To prevent it from entering the bell-jar the contrivance re-

presented in the above cut was resorted to. The exhaust pipe, represented by D, enters through the india-rubber cork of a wide-mouthed quart bottle, and passes down almost to its bottom. The tube connecting with the bell-jar to

be exhausted, C, terminates on the inside of the bottle just below the cork, and so likewise does the tube forming the mercury gauge. When the water regurgitates it fills the bottle nearly to the top, but not a drop ever passes over into the bell-jar. On starting a fall of water again through the long exhaust pipe, the water in the bottle is entirely and at once removed by means of the syphon, and the exhaustion of the air follows immediately.

CORRESPONDENCE.

JOULE AND SCORESBY ON THE MECHANICAL VALUE OF ELECTRO-MAGNETISM, STEAM, AND HORSES.

To the Editor of the Chemical News.

SIR,—You will perceive by the *Proceedings of the Manchester, Literary, and Philosophical Society* that, in consequence of the criticism in the CHEMICAL NEWS, Dr. Joule has withdrawn the details of his theory, and substituted others.

I have now tested, by facts and experiments, his new theory, and find it as untenable as his old one.

I hope shortly to show this in detail, and I feel more and more convinced that facts are inconsistent with the theory of the invariable mechanical equivalence of heat.—I am, &c.,

H. HIGHTON.

Putney, April 10, 1871.

COMMERCIAL ANALYSIS.

To the Editor of the Chemical News.

SIR,—Having for some time past been struck with the conflicting results obtained by chemists for commercial analysis, I made the following experiment, and thinking that it may interest some of your readers, I beg to forward you the particulars and results.

A sample of ordinary superphosphate of lime was taken and reduced to a fine state of division, and to ensure greater uniformity, was passed several times through a fine sieve. Seven tins were then filled from the sifted sample, sealed up in the presence of a disinterested witness, and sent to seven different chemists. In due course the following results were obtained:—

Amount of soluble phosphate of lime contained in a sample of superphosphate of lime received from—

I.	II.	III.	IV.	V.	VI.	VII.
25·46	19·48	24·43	20·33	22·74	19·81	24·52

From the above you will see there is a difference of nearly 6 per cent soluble phosphate in the seven different analyses, representing a money value of at least 18s. per ton.

The chemists were all well-known men; three of them respectively Chemists to the Agricultural Societies of England, Scotland, and Ireland. Three of the others men whose analysis is always taken in commercial transactions. In the face of this, how is it possible for manufacturers to guarantee the quality of their goods, and how can the public be expected to have any faith in chemical analysis?

The sample was so carefully prepared, that I have no hesitation in stating that there ought not to have been a difference of more than 1 per cent in any of the analyses.

I am unwilling to suppose carelessness in either case, so can only conclude that different chemists have different methods of determining soluble phosphate of lime, and that all the methods do not give the same result.—I am, &c.,

EDW. PURSER, JUN.

London, March 30, 1871.

MISCELLANEOUS.

Successor to the Late Dr. P. Bolley, at the Federal Swiss Polytechnic School, at Zürich.—From a communication addressed to us, from Turin, dated 21st March last, we learn with great pleasure that the Council of the School just named has appointed Dr. Emile Kopp as Professor of Technology in the room of the late lamented Dr. Bolley. Professor Kopp's merits, during the time he

has held the Professorship at the Institute Superiore, at Turin, have been gracefully acknowledged by the Italian Government, it having pleased H.M. King Victor Emmanuel to grant to Dr. Kopp the dignity of Commandeur de l'Ordre Equestre de la Couronne d'Italie. We sincerely congratulate Dr. Kopp, and no less so the Government of the Helvetian Republic, for having secured the services of a man so eminently well suited as Dr. Kopp to the important Professorship vacant by the demise of Dr. Bolley.

Natural Science at the Universities.—Of seven open scholarships at Christ College, Cambridge, two for Natural Science have been awarded to Mr. Elwes, of University College, London, and Mr. Jude, of King's College School, London. The scientific teaching in the London colleges is beginning to reap its fruits at the elder universities. In the case of Mr. Jude, his success may be looked upon as the result of throwing open to the pupils of the school the chemical and physical laboratory teaching previously confined to the students of the College, thus solidifying and bringing to a practical test the knowledge acquired in lectures. Should the University of Cambridge carry out the proposal, as there seems every probability of its doing, to admit modern languages in lieu of Greek, the modern departments of schools will soon be rivalling the classical sides in the universities as well as in the general business of life.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 3, 1871.

This number opens with a communication from Dr. A. W. Hofmann, announcing the establishment of an Italian Chemical Society, under the auspices of Dr. Canizzaro. This Society will publish a periodical under the superintendence of MM. Schiff, Tassinari, Körner, Paterno, and Gabba, as joint editors. The above-quoted number contains the following original papers and memoirs:—

Analysis of a Fossil Thigh-Bone of a Child (aged apparently from 5 to 7 years) taken from an Ancient Tumulus near Ohlsdorf (Hamburg).—F. Wibel.—The bone here alluded to belongs to the so-called "bronze period." The results of the analysis are, in 100 parts—Organic matter, 12·52; calcic phosphate, with traces of magnesic phosphate and fluoride of calcium, 74·99; carbonate of lime, 5·48; salts and mineral impurities, 7·01; nitrogen, 1·82.

Formation of Native Azurite (Blue Carbonate of Copper).—F. Wibel and E. Tüngel.—The authors have tested large quantities (25 grms.) of the Siberian mineral for ammonia, in order to see whether the intense blue colour exhibited by azurite may be due to the presence of an ammoniacal compound of copper. The result of repeated experiments in this direction were negative; but, when a solution of sulphate of copper is heated along with lumps of white marble to 200° in a sealed tube, and the green carbonate of copper thus formed left in the tube for several months, the authors observed the formation of an intensely blue-coloured carbonate; while, at the same time, all the water in the tube (although yet sealed) had disappeared, crystals of gypsum being simultaneously deposited. The difficulty of properly separating from each other the two carbonates (green and blue) prevented the making of an analysis, but the surmise is that azurite is formed from malachite by absorption of carbonic acid and loss of water.

Gold from Vancouver Island.—F. Wibel.—From a well-crystallised sample weighing 26½ grms., a portion was taken for analysis; sp. gr. at 22°, 18·5. The sample contains, in percentages—Gold, 91·86; silver 6·63; copper, 1·0; iron, 0·51; no mercury, lead, nor other metals.

Presence of Sarco-Lactic (Flesh-Lactic) Acid in the Urine of a Patient Suffering from Trichinosis.—Th. Simon and F. Wibel.—This brief notice records the fact that the testing of the urine of a patient alluded to contained that peculiar form of lactic acid which is met with in meat. The authors obtained the zinc salt of the body alluded to, $Zn_2(C_3H_5O_3)_2H_2O$. The presence of this acid in the excreta of a patient suffering from this disease is rather interesting, as indicating the increased activity of oxidation and rapid decomposition going on in the human system, the acid alluded to being the product of the oxidation of fats and albuminous compounds.

Lecture Experiment to Illustrate the Action of Dilute Sulphuric Acid upon Starch.—A. Vogel.—The author says that, since nearly all kinds of writing paper are nowadays so very largely sized with starch that they are coloured blue by a dilute solution of iodine, the following experiment may be made to illustrate visibly the change which starch undergoes when acted upon by dilute sulphuric acid, for which purpose writing or other figures are traced on the paper with very dilute sulphuric acid, and a gentle heat applied, care being taken not to char the paper. When next a dilute solution of iodine is painted over this paper, the portion acted upon by the dilute acid remains white, while the rest becomes blue; but since, in course of time, this blue colour disappears altogether, the same piece of paper may be repeatedly used for this experiment.

Contribution to our Knowledge on the Reaction between Urea and Nitrous Acid in Aqueous Solution.—A. Claus.—This lengthy paper contains an account of the author's researches, bearing upon the true acceptation of the formulæ according to which the reaction alluded to takes place. The paper is, notwithstanding its value for theoretical chemistry, not well suited for useful abstraction.

Decomposition of the so-called Sulpho Ureas by Nitrous Acid.—A. Claus.—This essay is an appendix to the paper just alluded to by the same author. The following sections are contained in this paper:—Action of nitrous acid upon substituted ureas; diphenyl-sulpho urea; sulpho urea; sulphocyanide of ammonium.

Some of the Derivatives from Aceto-Phenon.—A. Emmerling and C. Engler.—This essay is divided into the following chapters:—Secondary ethyl-benzol-alcohol—

$$C_6H_5C\left\{\begin{matrix}H\\OH\end{matrix}\right\}CH_3;$$

chlorethyl-benzol, $C_6H_5.CHCl.CH_3$; synthesis of styrol; bromated aceto-phenons; aceto-bromphenon, $C_6H_4Br.CO.CH_3$; bromaceto-phenon, $C_6H_5.CO.CH_2Br$.

Relation existing between the Chemical Properties of the Gases and their Refractive Power for Light.—F. Mohr.—This valuable physico-chemical treatise is not well suited for any useful abstraction. This observation equally applies to the next treatise by the same author.

Optical Proof of the Nature of Water of Hydration.

Behaviour of Chlorinated Phenols and Nitric Acid.—A. Faust.—This brief notice only refers to a question of priority of discovery made by the author, and published, but ignored by M. P. Weselsky, who has taken up the same subject three years later.

Preliminary Notice.—F. Sajohelyi and M. Ballo.—After briefly referring to the experiments on solidification (really hydration and freezing of that hydrate) by the last-named of the authors, they now state that they have obtained what they call chloroform snow and iodethyl snow, by directing a rapid and moist current of air upon these fluids contained in shallow basins. As regards the real nature of these solid substances, their experiments are not yet quite finished.

Oxypicric Acid (Styphnic Acid).—J. Schreder.—The acid named is identical with trinitro-resorcic acid; it is reduced by the action of tin and hydrochloric adid, yielding readily the crystalline salt—

$$C_6\left(\begin{matrix}H\\OH\\OH\\NH_2.HCl\\NH_2.HCl\\NH_2.HCl\end{matrix}\right)+SnCl_2.$$

This salt, treated with sulphuretted hydrogen, yields the hydrochlorate of the corresponding triamido compound, which, in its turn, yields, by the action of oxidising substances, a compound analogous to the azo-triamido-phenol. Several other reactions and formulæ are recorded. The extract of sapan wood, the best material for obtaining oxypicric acid, yields, by fusion with solid caustic potassa, a large quantity of resorcine.

Contribution to the History of Guanidine.—A. Bannow.—This paper treats at length on the preparation of guanidine by means of the action of iodide of cyanogen upon alcoholic solution of ammonia in a sealed tube, and heating in a water-bath.

Preparation of Pure Benzol.—Dr. A. W. Hofmann.—Illustrated with a woodcut, and, moreover, mainly the reproduction in German of Mr. Mansfield's "Researches on Coal-Tar" (*Chemical Society's Quarterly Journal*, vol. i., p. 244).

Decomposition of Ferricyanide of Potassium by Sunlight.—A. Vogel.—This paper bears chiefly on the fact that the decomposition alluded to has been already long known. Among other papers published on this subject, and here quoted, we mention Dr. Schönbein's "Observations on the Sensitiveness of the Ferro- and Ferri-Cyanides of Potassium (Poggendorff's *Annalen*, Bd. 67, 1846).

Peculiar and Improved System of Sewers.—Captain Liernur.—This lengthy essay is, however interesting the subject may be, not well suited for abstraction. In practice, as far as experience can decide, the author's system is a decided improvement, since it saves the use of large quantities of water for carrying off sewage and fœcal matters, and yields a valuable and concentrated manure.

No. 4, 1871.

This number contains the following original papers and memoirs:—

A Base Homologous with Cyanethine.—A. G. Baeyer.—This essay is divided into the following sections:—Chlorocyanmethine,

$C_6H_8ClN_3$; bromocyanmethine, $C_6H_8BrN_3 + 3H_2O$; periodides of these bases; cyanmethine-biniodide, $C_6H_9N_3.I_2$; constitutional formulæ of these bodies.

Observations on Ballo's Alleged Hydrate of Sulphide of Carbon.—V. Wartha.—This paper contains a refutation of the statement made by M. Ballo, that the congealed sulphide of carbon is a solidified hydrate of that substance. The author, after referring to Dr. Thilorier's discovery of solidified carbonic acid (1835), points distinctly out that M. Ballo is wrong, while he proves the correctness of his own experiments.

Law of Avogadro.—J. Thomsen.

Contribution to our Knowledge of the Sulpho-Nitrogen Acids (Sulphoxyazo-Acids).—A. Claus.—This lengthy memoir contains the following sections:—Disulpho-hydroxyazotate (*azosaures*) of potassa, $(NOH)2(SO_3K)+2H_2O$; sulphazonate of potassa, $(NH.NO_2K).4(SO_3K)=K_5N_3HS_4O_{14}$; oxysulpho-zotinate of potassa, $(N_2O_2).4SO_3K=K_4N_2S_4O_{14}$; trisulphoxy-azotate of potassa—

$$(NO).3(SO_3K)+H_2O=K_4NS_3O_{10}+H_2O.$$

The paper contains the exhaustive description of the preparation, reactions, and properties of these salts, and the products of their decomposition.

Isomeric Modification of Sulphocyanide of Potassium.—A. Fleischer.—This essay contains the account of a series of experiments made by the author in order to obtain from persulphocyanic acid, by treating it with alcoholic solution of potassa, the modification of sulpho-cyanhydrogen and sulphocyanide of potassium isomeric with essential oil of mustard (*senföl*) containing sulphur. The salt obtained by the author (isosulphocyanide of potassium, $2KCSN+H_2O$), is at once recognised by its behaviour with per-salts of iron; because, since the ordinary sulphocyanide of potassium yields, with the per-salts of iron, the generally well-known very characteristic blood-red colour, the isosulphocyanide of potassium obtained by the author yields, with a single drop of a neutral solution of the iron salt, a brown colouration, which disappears upon the addition of more of the iron solution, or also by strongly agitating the liquid. The reactions of the ordinary sulphocyanide and isosulphocyanide are described at length, and prove that the iso-salt is really a very different modification of the ordinary salt.

Action of Sulphuric Acid on Opianic Acid.—C. Liebermann and C. Chojnacki.—This exhaustive essay does not admit of any useful abstraction, notwithstanding its intrinsic scientific merits.

Law of Avogadro.—Dr. R. A. Mees.—A learned algebraico-physical essay.

Heat Set Free by the Action of Oxygen upon Hydrochloric Acid.—F. Hurter.—This paper is written with the view of proving that M. Thomsen's views expressed on the researches of Mr. H. Deacon, concerning the heat set free by the action of oxygen upon hydrochloric acid, are erroneous, and due to the fact that M. Thomsen did not read Mr. H. Deacon's original memoir, but a badly-made and translated abstract thereof (CHEMICAL NEWS, vol. xxiii., p. 99).

Lecture Experiments.—Dr. A. W. Hofmann.—Reserved for full translation.

Direct Substitution of the Alcohol Radicals for the Hydrogen of Phosphuretted Hydrogen.—Dr. A. W. Hofmann.—This lengthy and learned essay does not admit of any useful abstraction, taking into consideration the great merits of the author's work.

Sensitiveness for Light of the Haloid Salts of Silver, and on the Connection Existing between Optical and Chemical Absorption of Light.—C. Schultz-Sellack.—The following chief results may be drawn from the author's researches:—All rays of coloured light which are optically perceptibly absorbed by the haloid salts of silver in films of some few millimetres' thickness cause a chemical decomposition. The absorption of light is in these substances always connected with chemical action. All the haloid compounds of silver are chemically affected and altered by all those rays of light which the salts absorb in perceptible quantity.

Les Mondes, March 9, 1871.

This number contains only one original paper relating to chemistry, viz.:—

Preservation of Meat by the Aid of a Low Temperature and by Drying in Vacuum.—C. Tellier.—As regards the application of cold, the author uses dry cold air at 0° or −1°, but the mode of producing it is not mentioned. The drying in vacuum takes place while there is simultaneously present a substance which readily and rapidly absorbs water—as, for instance, sulphuric acid or chloride of calcium—with which, of course, the meat does not come into contact.

Discovery of a Layer of Phosphate of Lime near St. Petersburg.—Rev. F. Moigno.—The author states that, while some workmen were engaged in making excavations for putting in drain-pipes, they found, at 1·8 metres below the surface, a deposit of native phosphate of lime, similar in texture and properties to that recently found near Charleston, South Carolina, U.S.

The American Journal of Science and Arts, March, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Discovery of Actual Glaciers on the Mountain Slopes of the Pacific Slope, U.S.—C. King.—This exhaustive essay is a valuable contribution to the physical geography and geology of the western part of the great Transatlantic Republic.

Some Rocks and other Dredgings from the Gulf Stream.—S. P. Sharples.—This paper contains the results of some chemical analyses of bone, rock, and ooze (soft mud or slime) from the bed of the Gulf Stream between Florida and Cuba, obtained at various depths while dredgings were being made for the coast survey of the United States. The bone (a portion of a rib of a manatee, an herbivorous cetacean) was dark-coloured, and almost destitute of organic matter, but still showed distinct traces of fibrous structure; its density (sp. gr. 2·83) was much greater than that of recent bone (sp. gr. 2·07). The piece was found at 106 fathoms' depth, and contained, in 100 parts—$Ca_3P_2O_8$, 62·40; $Fe_2(P_2O_8)$, 7·60; $CaCO_3$, 26·47; SiO_2, 0·34; H_2O + organic matter, 2·67. The following is the analysis of a piece of hard dark-coloured rock taken at 100 fathoms' depth off Sand-Key, Florida (sp. gr. 2·81); 100 parts contained—$CaCO_3$, 36·50; $Ca_3P_2O_8$, 35·54; SiO_2, 0·49; Fe_2O_3, 14·77; $MgCO_3$, 10·56; H_2O + organic matter, 1·43. Ooze, in 100 parts—$CaCO_3$, 85·62; $Ca_3P_2O_8$, 0·18; SiO_2, 1·52; Fe_2O_3, 0·31; $MgCO_3$, 4·26; H_2O + organic matter, 8·15. This paper contains, moreover, a series of analyses of various corals, and of two more specimens of rock very similar to that here mentioned.

Porcelain Rock of China.—Baron von Richtenhofen.—Reserved for full reproduction.

Notes on Granitic Rocks.—Dr. T. Sterry Hunt.—The continuation of this excellent and exhaustive essay; this portion containing the following sections:—Granitic veins of Maine, Brunswick, Topsham, Paris (U.S.), Westbrook, and Lewiston; crystalline limestones; Danville, Ketchum; denuded granitic masses; banded veins; Biddeford, Sherbrooke; veins at various New England localities; mineral species of these veins; veins in erupted granites; geodes in granites; veins distinguished from dykes; Volger and Fournet on the origin of veins; certain fissures and geodes distinguished from veins opening to the surface; temperatures of crystallisation of granitic minerals.

Geology of the Eastern Uintah Mountains.—Professor O. C. Marsh.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, January, 1871.

This very small number does not contain any papers relating to chemistry and collateral sciences.

NOTES AND QUERIES.

Sugar Refining.—Can any of your readers give me a description of the Seyfert process (sulphuric acid) for sugar refining, as used at New York and elsewhere?—J. T. A.

Ammonia Sulphate from Gas Liquor.—Can you inform me where or how to obtain *practical* information on the above manufacture as adapted to a small gas-works, the sulphate being required in the crude state only?—AMMONIA.

Ammonium Salts.—I should be glad if any correspondent of your valuable journal would kindly inform me whether sulphocyanide of ammonium (rough impure, as found now in the market) can be directly used for the production of ordinary ammonium salts, as sesquicarbonate, strong solution of ammonia, &c.—H. M.

Hyposulphite of Sodium and Silver.—Will you kindly inform me through the CHEMICAL NEWS whether the hyposulphite of soda and silver, formed by dissolving a salt of Ag in hyposulphite of soda, is *poisonous*; and, if so, what quantity of it would constitute a dangerous dose? I have not been able to find any statements or records of experiments on the question in books; can you refer me to any? In Watts's "Dictionary," in articles on hyposulphites, I find several references to "Herschel;" can you tell me how to find the memoir referred to?—SAFETY.

MEETINGS FOR THE WEEK.

MONDAY, 17th.—Medical, 8.
—— London Institution, 4.
TUESDAY, 18th.—Zoological, 9.
—— Civil Engineers, 8.
—— Royal Institution, 3. William Pengelly, Esq., F.R.S., F.G.S., "On the Geology of Devonshire, especially of the New Red Sandstone."
WEDNESDAY, 19th.—Society of Arts, 8.
—— Meteorological, 7.
THURSDAY, 20th.—Chemical, 8.
—— Royal Society Club, 6.
—— Royal, 8.30.
—— Royal Institution, 3. Prof. Tyndall, "On Sound."
FRIDAY, 21st.—Royal Institution, 9. Prof. Blackie, F.R.S.E., "On the Pre-Socratic Philosophy."
SATURDAY, 22nd.—Royal Institution, 3. Mr. Lockyer, "On Astronomy."

NOTICE TO AMERICAN SUBSCRIBERS.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 595.

ON THE FORCE EXERTED BY DETONATING GASEOUS MIXTURES.

By Dr. BERTHELOT.

As an appendix to, and completion of, my investigations on the force exerted by the explosion of powder and other explosive substances, I have considered it proper to collect together some analogous facts bearing upon the chief detonating gaseous mixtures:—

Nature of the explosive mixture.	Quantity of heat disengaged by 1 kilo (1).	Volume of 1 kilo. of the mixture (2).		Pressure exerted at the moment of combustion at constant bulk (3). in atmospheres.
	Caloric.	Initial M.C.	Final M.C.	
H_2+O_2	3,280,000	1·86	1·24	20
$C_2O_2+O_2$	1,570,000	0·75	0·50	24½
$C_2H_4+4O_2$	2,375,000	0·84	0·84	33
$C_4H_6+6O_2$	2,530,000	0·72	0·72	41
$C_4H_2+5O_2$	2,800,000	0·74	0·63	44½
$C_4H_8+7O_2$	2,300,000	0·70	0·78	39
$C_8H_8+12O_2$	2,450,000	0·63	0·72	46
$C_8H_{10}O_2+12O_2$ (vapour of ether)	2,400,000	0·59	0·75	49
$C_{12}H_8+15O_2$ (vapour of benzine)	2,300,000	0·60	0·63	45
$C_4N_2+4O_2$	2,300,000	0·58	0·58	49½

(1). This quantity has been calculated according to the heat of combustion, as adopted in my memoir in the *Annales de Chimie et de Physique*, 4th series, vol. vi.

(2). This volume is taken at a pressure of 0·760 metre, and at 0°. The water is supposed to be as vapour—that is to say, the formulæ wherein this figure occurs only apply to degrees above 100° generally.

(3). This pressure is calculated according to the laws of Marriotte and Gay-Lussac. The following values for the specific heat by constant volume have been taken:—

$H_2O_2 = 7·2$ for 18 grms.
$C_2O_4 = 7·2$ „ 44 „
$N_2 = 4·8$ „ 28 „

It is supposed that the explosive gaseous mixture has been made at atmospheric pressure.

According to this tabulated review, the maximum effect which is obtainable from 1 kilo. of each of these explosive gaseous mixtures varies only from one to two, and is about equal for the various hydrocarbons; but this effect surpasses that of all solid, as well as of all liquid explosive compounds. With hydrogen and oxygen, for instance, it is five times greater than that of powder, and two and a half greater than that of nitroglycerine; with the hydrocarbons, it is four times greater than that of powder, and twice greater than that of nitroglycerine. Notwithstanding the diversity of composition and condensation of the gases above named, the pressure varies only from one to two. When, instead of oxygen, atmospheric air is taken for the mixtures, the maximum effect of a given weight of the combustible gas does not change, but the pressures become less by half, or even below that, in consequence of the necessity of heating the nitrogen. It might have been expected that protoxide of nitrogen could have been substituted, with advantage, for pure oxygen, because the protoxide yields, by its decomposition, a volume of nitrogen, and an additional quantity of caloric; but experiments proved that this advantage is more than outweighed by the necessity of heating the nitrogen. The gaseous mixtures we have experimented with are supposed to be made under atmospheric pressure. The pressure theoretically exerted by them lays between 20 and 49 atmospheres, each at 15 lbs.' pressure to the square inch, and is very widely distant from the pressure exerted by the bulk of the solid and liquid explosive substances we are acquainted with, a result the very opposite to that which was supposed to be the case by most people until now. In order to obtain a pressure more nearly like that exerted by solid and liquid explosive substances, it would be necessary to compress the explosive gas mixtures previous to exploding them; but even then, in order to come up to the force of pressure exerted by solid and liquid explosive substances, it would be required to reduce, by strong pressure, the bulk of the gaseous mixture to the thousandth of its initial volume; that is, in other words, it would be required to make these gaseous bodies to the same density as that of solids and liquids. Leaving out of the question for the moment the difficulty of this operation, the result would be the liquefaction of most of the hydrocarbonated gases; while the oxygen remaining in the state of gas, the result would be the destruction of the homogeneity of the explosive mixture, and, accordingly, also the possibility of obtaining its instantaneous explosion by a spark. The liquefied protoxide of nitrogen would be of some advantage in this emergency, since I have found that, when that liquefied gas is mixed with liquefied hydrocarbons, mixtures are obtained the explosive force of which is comparable to that exerted by nitroglycerine or mixtures of chlorate of potassa with gun-cotton and picrate of potassa; it would, however, be difficult to obtain the instantaneous explosion of mixtures of the liquefied gases alluded to. In order, however, to give some proof of the great explosive power of these liquefied mixtures containing liquid protoxide of nitrogen, I quote the following figures:—

Explosive material.	Quantity of heat disengaged by 1 kilo.	Volume of gas produced. M.C.	Product of these figures.
Liquid protoxide of nitrogen mixed with liquefied olefiant gas, or with isomeric carburets, or with ordinary ether	1,300,000	0·76	990,000
Liquid protoxide of nitrogen and liquefied acetylen	1,400,000	0·72	1,000,000
Liquid protoxide of nitrogen and liquefied cyanogen	1,400,000	0·69	970,000
Nitroglycerine	1,280,000	0·71	910,000

These numbers, it should be stated, are the result of calculation, and only approximative, not rigorously exact. —*Moniteur Scientifique.*

ON THE CONDUCTING POWER OF VARIOUS METALLIC SULPHIDES AND OXIDES FOR ELECTRICITY, AS COMPARED WITH THAT OF ACIDS AND SALINE SOLUTIONS.*

By WILLIAM SKEY,
Analyst to the Geological Survey of New Zealand.

THE author refers to his results, as stated in a former paper ("On the Electro-Motive Power of certain Metallic Sulphides, &c.,") in which paper the conductivity of these sulphides for electricity is shown.

* Abstract of a paper read before the Wellington Philosophical Society, January 29, 1871.

He then refers to the order of this conductivity as given in the latest works on electricity now to hand, and states there is a great discrepancy between his observations and those upon which this order is founded, since a great many sulphides and oxides are far better electric conductors than the best conducting acids or salts which are instanced in these tables, or have been experimented with by the author, the reverse being affirmed of them in such works.

The manner in which these results were obtained is then stated, and a table embodying them is given, from which it appears that the following minerals are better electric conductors than nitric acid (concentrated), which is the best conducting non-metallic liquid yet tested by him:—Mispickel, galena, sub-sulphide of copper, copper pyrites, protosulphide of iron, tin pyrites, nickel pyrites, sulphide of bismuth, magnetic iron ore, graphitic tellurium, binoxide of manganese, iron pyrites, oxide of zinc. Titanic iron and boulangnite were found but feeble conductors.

The following minerals were proved to be non-conductors, or comparative non-conductors:—Sulphide of molybdenum, zinc blende (cryst.), stibnite (cryst.), cinnabar (compact red variety, cryst.), orpiment, bouranite (cryst.), manganese blende (not cryst.), proustite, pyrargite, silver glance, horn silver, carbonate of iron (black variety cryst.), calamine, chrome ore (cryst.), tungstate of iron (cryst.), specular iron ore (cryst.), rutile, bramite, tin ore (cryst.), leverite (cryst.), oxides of copper (sub and proto, cryst.), iserine, oxychloride of copper, &c.

These results, when checked and added to by further experiment, especially by experiments upon larger mineralogical collections, and also upon certain pure sulphides and oxides as chemically prepared, and in allotropic states, will, no doubt, prove useful towards the ready discrimination of minerals in certain cases, and interesting in relation to the science of electricity generally.

As a step towards testing these pure and chemically prepared sulphides, the author finds sulphide of mercury is a good conductor, whether the precipitate is only dried or sublimed, so long as it retains its dark colour. Sulphide of silver, on the other hand, neither conducts when merely dried, nor yet when submitted to a dull red heat.

The author hopes that further inquiry into this behaviour of metallic ores in regard to electric currents will furnish evidence of the particular law which regulates such behaviour.

SPECTRUM ANALYSIS
IN ITS APPLICATION TO THE
BESSEMER PROCESS FOR THE MANUFACTURE OF STEEL.*

By Professor ROSCOE, F.R.S.

(Concluded from p. 176).

LET us now proceed to the other point which we have to reach, namely, the examination of the Bessemer flame.

I have already said that I should not feel myself justified, nor should I be qualified if justified, in entering into a detailed statement of the chemical reactions which go on in this most important and interesting process; for one good reason is that there are many here who know much more about it than I do, and another reason is that I think that even those who know most about it know, perhaps, very little. I think, however, that we may take it that, in the first place, the changes which occur are mainly as follows:—The silicon and carbon which are contained in the iron are oxidised to begin with. I suppose it is a fact that, in the first place, the carbon or graphite which is contained in the pig-iron is converted into combined carbon. We find that, in the second stage of the process, the carbon has already diminished somewhat, but that it has not diminished in such a large proportion as the silicon; and then the carbon gradually diminishes out till we get to the last portion, where it has not altogether gone, but where we have about 1-10th or 2-10ths of carbon left; that the silicon then has diminished down either to something like a trace, or 2-100ths per cent.

Now, with regard to the manganese. This, as you all know, plays a most important part in the process, but we know that the ores of iron used for the Bessemer process differ widely in their amount of manganese. The irons used in Styria differ very widely from those used at the Atlas Works, Sheffield. The Dowlais iron too, and, I believe, almost all our English iron ores contain very much less manganese than the iron which is worked in Styria; and, therefore, since we have here in England to deal with an iron containing less manganese, we shall not expect the manganese, as far as regards the spectroscope, to play a very important part. With regard to sulphur and phosphorus, I have but little to say. The sulphur apparently diminishes somewhat in the iron. We find that in iron containing a small trace of sulphur that trace of sulphur either diminishes slightly, or altogether disappears, or leaves very little trace; whereas the phosphorus is scarcely got rid of at all. The reasons for this I will not attempt to enter into now. I will not attempt to explain them, but there are reasons which I should like to state as to why we should not expect to see in the flame reactions either of silicon, or of phosphorus, or of sulphur.

It is well known to all present that it is very necessary to stop the blast at the exact moment that the carbon is burnt out. The mode of ascertaining this is by the dropping of the flame. Now, it has struck many people that it was very probable that this indication of the dropping of the flame by which the end of the process was ascertained, might be ascertained with greater accuracy if, instead of looking at the flame as a whole, we were to look at the component parts of the flame; that is to say, if, instead of looking at the flame with the naked eye, we were to look at it through a prism, we then should most likely see certain effects which would not be visible, or the effects which are visible would probably become more decided and more striking if observed in this way.

Let us first try to get a clear idea of the general appearance of the Bessemer flame, and then endeavour to explain what we see.

Spectroscopic Appearance of the Bessemer Flame.

Time. Mins., about.	Appearance to Eye.	Appearance of Spectrum.
First Stage:—		
0— 4	No flame seen.	Faint continuous spectrum, due to sparks of burning metal.
4— 6	Small pointed flame.	Brighter, with yellow sodium line flashing.
6— 8	Unsteady flame, and explosions.	Bright, continuous, with sodium line permanent, red lithium line, red and violet potassium line.
Second Stage:—		
8—10	Very bright and dense flame.	Bright carbon lines, in red, green, and blue, with preceding spectrum.
10—14	Flames less dense, but bright.	Bright green carbon lines more distinct.
Third Stage:—		
14—16	Flame diminishing in size and intensity.	Bright green carbon lines become faint.
16—18	Flame drops. Blow ends.	Bright green carbon lines suddenly disappear, leaving continuous spectrum.

* A Lecture delivered before the Iron and Steel Institute, on Wednesday evening, March 29th, 1871.

The bright lines of iron, hydrogen, nitrogen, and manganese have also been observed in the Bessemer spectrum.

We may divide the process into stages; and, to begin with, we notice that the Bessemer flame gives a continuous spectrum. At a certain period, which varies according to the heat, and according to the time which the whole operation takes, certain lines begin to make their appearance; and three lines appear, to begin with, namely, the yellow sodium line, the red lithium line, and the bright potassium line. Now, when the thing has gone on for a certain time, a change comes over the whole appearance of the spectrum. Lines begin to make their appearance in almost every portion of the spectrum, and at last we have a most complicated series of interspaced bright and dark bands; and you must imagine, if you please, that this is covered with a continuous spectrum. Then we get not a continuous spectrum, but one in which there is a whole series of bright bands. This spectrum is a very complicated one. At a certain period of the blow these lines again disappear, and at the last stage of the operation, we see the second spectrum repeated; and this is the point at which the flame drops, and it is the point at which it has been found, by practice, necessary to turn off the blow.

Understanding now what is observed,—understanding the four changes which occur in the different stages of the operation,—let us next try to find out what it really is that we are looking at in these bright bands. The question comes as to what these lines are caused by, and here, of course, we enter, to a certain extent, into the field of conjecture, because the subject is an exceedingly difficult one, and because the spectrum as seen is very complicated. Still, I believe, there is no doubt at all that the bright lines are mainly caused by carbon in some form or other. I will not undertake to say what the exact form of the carbon is. One very interesting fact, with regard to the spectra of bodies such as carbon, is, that we find, under certain circumstances, they vary. Even such a body, for instance, as nitrogen gas can be made to exhibit two distinct spectra. Under certain circumstances, we get one series of bands; under other circumstances we can get a different series of bands. Another variation of the same sort is observed in the case of the calcium spectrum. The calcium spectrum, as seen in the Bunsen gas flame, differs from that which is seen by aid of the intense electric spark. In one case there are broad bands, and in the other fine bright lines. We can explain why there is this difference, because we know that at the low temperature of the Bunsen gas flame the calcium compounds are not decomposed, and that we are in that case really looking at the spectrum of a compound,—probably calcium chloride, or calcium oxide; whereas, when we heat the compound so intensely as we do in the bright electric spark, we get the true spectrum of the metal, and which cannot be changed or varied. But then, when we come to nitrogen gas, we are not able to explain matters so well. In looking at two of the spectra of nitrogen,—one which is seen under low pressure, and one which is seen at atmospheric pressure—we observe that there is a very considerable difference between them. The low pressure spectrum contains a series of bands which are not seen in the high pressure spectrum. What the cause of this is we cannot tell. In this case we enter into the region where we are on the border-land of knowledge and ignorance. We do not pretend to say what is the cause of this: we must be satisfied at present with recognising the fact.

Let us now turn to the spectrum of carbon. We find that, under certain circumstances, carbon can be made to give very different spectra. The carbon spectrum obtained by burning olefiant gas in oxygen gives bright bands. If we pass an electric current through a small quantity of carbonic acid gas in these Geissler tubes we get a second spectrum. There is still another spectrum differing from these two.

In the Bessemer flame, there are lines in the violet which are not identical in position with the known lines of carbon; still I think there is little doubt, seeing, in the first place, that carbon is capable of giving different spectra, as we have shown in three instances, that this Bessemer flame spectrum is probaly a further modification of the carbon spectrum. It is a remarkable fact that it has not been found possible to get, artificially, the peculiar spectrum which is seen in the Bessemer flame, and seen in several other flames—seen, for instance, as is well known, in that beautiful flame which is generally emitted when the spiegel iron is allowed to run in. It is seen also in a hot-blast furnace. It has been seen by a gentleman who has devoted some attention to this subject—Dr. Watts, an old pupil of mine, who has examined this carbon spectrum with some care. He has noticed that the Bessemer spectrum is observable in the hot-blast furnace when they turn the blast down to the bottom of the furnace. In certain cases, where a very high temperature is brought to bear upon burning carbon, this same flame has been exhibited.

I need not say that, if we know little about the chemistry of the process, which goes by the name of the illustrious President of the Iron and Steel Institute, we know still less about the constitution of the spectrum; and it requires still that experiments should be conducted on a much more extended scale than they have been at present, and with an instrument of much higher power than we have yet been able to bring to bear upon the subject, in order that we may separate these lines into their exact positions, or ultimate parts, if I may use that expression, and that we may thus recognise the different substances which are present. This, however, is a matter of very great difficulty. Imagine, if you please, that we have to be provided with such an instrument as you see before you, the beautiful automatic spectroscope of Mr. Browning; imagine that we have to go with this instrument into works fitted up for iron works. The instrument must be so placed on a stand that it can be easily carried about. Then we must carry with us an induction coil and a number of these tubes, because we cannot trust to any scale for measuring these lines; and we must have the light from the Bessemer flame in one part of the eye-piece; and we must have the light from the iron, carbonic acid, and hydrogen, and the various other bodies, in another part of the field, or otherwise we shall never get a good result. These difficulties, you see, are not small in coming to an exact conclusion with respect to the composition of this flame.

Now we must pass on to the last part of our subject, and that is the most difficult one—the practical application of these principles.

Assume, for a moment, that these lines are carbon lines, and of that, as I have said, there can be no doubt. Those who have read the literature on this subject will know that it has been stated, and stated with some degree of confidence, as if it were a well-established and well-recognised fact, that these bright lines are mainly due to manganese. Now this I really cannot believe. I do not know what the exact appearance of the spectrum of a Bessemer flame is in which very large quantities of manganese are used; but this I do know, that, in such works as the Barrow Steel Works, where they employ an iron which we all know contains next to no manganese at all, these lines are as brightly seen as in those places in which a more manganiferous iron ore is employed; and I know, too, that these lines disappear as the carbon disappears; and, therefore, taking these together, although I will not say that there are no lines due to manganese, especially in the spectrum of such ore as is worked on the Continent, still I think we may take it that the manganese lines are a very unimportant portion of the spectrum in the flames which we see in England.

The first question which will naturally suggest itself is, Do these lines disappear at the point at which the blow is turned off? I think the whole evidence on this point is unanimous in showing that the lines disappear at the

time when it has been found necessary, by experience, to turn the blow off. The second question which we may find it necessary to ask ourselves is,—Can this point of decarbonisation be more accurately determined by the disappearance of the lines than by the unassisted eye of the workman? And the third question which we may put is,—Can we, by any application of the spectroscope, or by any determination of the disappearance or appearance of these lines—can we, by any observations made in this way, come to this point, that we shall be able to determine when the blow ought to be stopped, so as to leave in the steel the requisite quantity of carbon? These are the three points which we have to decide.

Now I believe that, as regards the first point, there is no practical difficulty about it. I believe it is a point which can be ascertained. As regards the question whether we can more accurately determine the point by the disappearance of these lines than is done at present by the naked eye, it appears to me that whether the adoption of the spectroscope becomes general depends upon the future—upon how far in future it will be found necessary to prepare steel containing the same degree of tensile strength, and containing, as nearly as possible, the same percentage of carbon. There is no doubt, however, that variations in the percentage of carbon must occur, even were it possible always to hit the point of decarbonisation, owing, among other causes, to variations in the temperature causing a larger or smaller quantity of the carbon in the spiegel to be burnt before the steel can be cast. But that a uniform steel can, as a general rule, be prepared when the charges are kept uniform by working by the unaided eye, is a fact with which we are all well acquainted. Still, under the most favourable conditions of uniform charges and careful working, exceptional and different blows occur; indeed, nothing is more striking than to observe when the conditions of uniformity are most favourable. Great inequalities in the blows, both as regards temperature and length of time, are needed for the decarbonisation, and there are blows which are termed "fiery" blows, or "lively" blows, which differ from the others. So much is this the case, that it is generally said by the workmen, I believe, that no two blows are exactly alike. We may well admit, even in spite of the discoveries which have been made, that we are still in the infancy of the steel manufacture, both as regards its chemistry, and probably, also, its mechanical and metallurgical details. The reference which was made by the President of the Institute, in his opening address, to Sir Joseph Whitworth's application of cast-steel under pressure, proves, I think, perfectly, that we are only just beginning to understand what we or our children will have to do in future. So it may be with the application of spectrum analysis. If we find that it is necessary to produce a steel varying, not to the extent of eight-, or six-, or four-, or two-tenths of carbon, but in which the amount of carbon does not vary beyond one-tenth, I think we shall be obliged to use the spectroscope.

In certain cases, however, the spectroscope has already proved itself of inestimable value in new works, and where different ores are needed to be used. On the Continent especially, it has been most successfully employed. From information which I have just received from Gratz, I learn that the spectroscope is largely used in Styria, Saxony, and Belgium. Indeed, at one place, it appears to have been impossible to produce a uniform steel until the spectrum reaction was introduced in 1869, and from that time the steel has not varied more than 5-100ths per cent of carbon. In England the conditions are somewhat different. We probably use a more uniform ore than the highly manganiferous ores employed on the Continent, and hence the spectroscope may be more valuable on the Continent, for this purpose, than it is or than it may be with us. At any rate, the spectroscope has not been so largely adopted with us as abroad, and this not because our steel-makers distrusted it, or were ignorant of the application, but because they saw no advantage in the employment of a more delicate test than that of the workman's eye.

We next pass to the third point, which is, perhaps, the most interesting and the most important of all, namely, whether it is possible (as I believe is done in Sweden) to stop the blow at a particular point indicated by means of spectrum analysis. Now, on this subject, I am glad to be able to give you some information—I am sure of interest, and I believe of importance. It has just been placed in my hands by a gentleman whose name you are all well acquainted with, and whom I am proud to be able to number amongst my pupils—a gentleman about whom I think we shall hear a great deal more before long. That gentleman is Mr. Snelus, who has been kind enough to help me here. He has put into my hands the result of a series of experiments which go to prove what appears to me to be a very important point, and that is, that not only does he find that the point of decarbonisation can be accurately determined by means of the spectroscope, but he finds also that it is possible, at the beginning or during the course of the blow, to predict how long the blow will be; that is to say, he can, in the middle of the blow, predict that the blow will last, for instance, eighteen minutes, and he finds that it does last eighteen minutes. Then he predicts twenty-four or twenty-five minutes, and he finds that it lasts twenty-three and a half minutes. He then predicted thirty-two minutes, in another blow, and he found that it did take thirty-two minutes; and so on with twenty experiments made both at Dowlais and Abervale. He finds that it is possible, by means of this reaction, to find when the blow will cease. You will all of you see the importance of this observation, because, if it enables him to tell at what point the blow would cease, it would enable him to stop three or four minutes before that time. It only, therefore, remains to know whether the steel, after having partially blown, as is the case in Sweden, is in a fit state to be used,—whether the last portion of the blow (the last two, or three, or even four minutes) does not, in some way, alter the quality of the steel besides getting rid of the carbon. For instance, if in the last portion of the blow a large quantity of silicon is got rid of, which it is necessary or desirable to get rid of, then if we stop three or four minutes before the natural end of the blow, of course we shall have a steel containing large quantities of silicon. The results are quite new, and, of course, they will have to be worked out; but I think you will all agree with me in congratulating Mr. Snelus on this very interesting observation, and in wishing him success in working it out to useful results.

I have now nearly done. I have only to say that I have also to-day received a note from another gentleman whose name is, perhaps, even still more familiar in the ears of all steel-makers—Mr. Bragg, of the Atlas Works,—who tells me, "In reply to your questions—(first), we are daily using the spectroscope in determining the point of the disappearance of carbon in the process; and (second), we are, to a certain extent, satisfied with the results." (He is careful to say "to a certain extent." He can scarcely say that he is fully satisfied.) "We have lately had a new instrument made by Mr. Browning. It has been an improvement upon the other which we had to begin with," and which, I believe, was got for them in the year 1863.

I will now show you the spectrum of iron and the spectrum of steel. I have a new method of showing these, which, I believe, is really better than any we have have had before. It consists of placing a bar of the metal at the bottom pole of the electric lamp. Here you have a beautiful series of bands. These lines, or, at any rate, some of them, have been seen in the Bessemer flame. The greater portion of the iron comes off in the molten state, either as fluid oxide, or fluid metal, and of course gives the spectrum which is due to that fluid state, namely, a continuous spectrum. But in the hottest part of the blast, a portion of the iron is seen in the gaseous state, and by direct comparison with the iron spectrum, I have got a

coincidence of the lines. In the iron spectrum before you, you see what masses of green lines we have; and I scarcely need to tell you that, in a more delicate and accurate instrument, these resolve themselves into whole systems of lines; and each one of these lines which we have in the iron spectrum has its dark representative in the solar spectrum. Hence Kirchhoff comes to the conclusion that iron is contained in the sun. Now, we will put a piece of steel into the apparatus, and a distinct difference will be noticed. Here, now, is the spectrum of steel. There are the steel bands; and you see that there is a large number of bands in the violet. I told you that in the Bessemer flame there were bands in the violet. These are the bands which I have no doubt are due to carbon, and I have no doubt that we are here really burning carbon. You see that the steel spectrum is decidedly different from the spectrum of metallic iron.

Some of our friends are very anxious that the spectroscope should do—I was going to say, *everything*—but, at any rate, more than turns out to be possible. They say, "We are very much obliged to you for coming here, and telling us how to find the point of decarbonisation, but we can do that for ourselves very well; but we shall be much more obliged if you can tell us about the phosphorus and about the silicon." I should be very glad to do so—*if I could*. There are some things which we can do, and other things which we can not do, and it appears to me that that is one of the things which we can not do; and now, if you will allow me, I will endeavour to give my reasons.

From what I have said you will observe that, in order that we should see the spectrum of a substance, it is necessary that it should be present in the state of a glowing gas. If it is present in the form of a liquid or a solid, it does not give us any distinct or characteristic spectrum. But if the body is present in the state of gas we can tell you that we have, for instance, phosphorus, or silicon, present.

Now, first, as regards silicon, the fact is that it is excessively difficult to get silicon in the state of gas. In fact, so difficult is it that all attempts to map with precision the spectrum of silicon have been in vain. The moment silicon boils it forms, as we know, the white oxide, or silica; and this white oxide may be melted by the heat of the oxyhydrogen flame, but it cannot be volatilised. This is, in my opinion, the reason why at the commencement of the blow we have a continuous spectrum, and while during the whole of the blow we have, more or less, a continuous spectrum, masses of silicates being shot out in that form,—little masses which are white-hot, but which do not indicate more than that they are solid bodies. Whether those masses contain silicon, or phosphorus, or sulphur, we cannot tell; and, therefore, though it is neither safe nor wise to predict beforehand, I do not expect to find that in future we shall be able to tell much about the silicon by these means.

Then with regard to the phosphorus. It is quite true that we can get the spectrum of phosphorus. It consists of three bright green lines. "Well, then," you say, "why don't you see the spectrum of phosphorus in the Bessemer flame?" Well, I think that the analysis of the slag will tell you why we do not see the spectrum of phosphorus. It is for a very good reason,—because the phosphorus is not there, or there is a very small quantity of it, and we know very well that it does not come out but remains with the iron.

I think, therefore, that it is rather hard upon us that we should be told, "Well, you cannot do us any good at all, because you cannot tell us anything about the silicon, and you cannot tell us anything about the phosphorus." Still, I think that what I have said, and especially what I have recently been informed of, will show you that spectrum analysis is not wholly without its use, and that we may believe that it will in time really come to be much more largely employed than it is, and that it will be able to tell you what we originally hoped it would be able to tell you —*when to finish your blow*.

I intended to say a few words about the presence of iron in the sun; but I am sure that I have exhausted your patience already, and therefore I have simply to thank you for the very kind way in which you have listened to what it has been my pleasure to bring before you.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

April 6th, 1871.

Professor FRANKLAND, F.R.S., President, in the Chair.

THE PRESIDENT, occupying the chair the first time since his election, returned his thanks to the Society for the honour conferred upon him, and expressed his readiness to discharge the duties of his office to the best of his abilities.

The following gentlemen were elected Fellows:—F. Coles, C. E. Groves, E. W. T. Jones, L. T. McEwan, J. L. Shuter.

The following papers were read:—

"*On Burnt Iron and Burnt Steel*," by W. MATTIEU WILLIAMS.

On page 7 of Dr. Percy's treatise on the "Metallurgy of Iron and Steel," he quotes the following conclusion of Mr. Riley:—"The property of becoming useless after exposure to a welding heat appears from the above experiments to be a special character of fused wrought-iron. The experiments have not been carried far enough to lead to any explanation of this: it may probably be due to the absence of a small quantity of carbon usually present in wrought-iron. In Bessemer's iron (Mr. Riley believes), there is no carbon, yet it certainly welds, though not very well."

Iron which has thus been damaged by re-heating is designated "burnt iron" by the workman, who also gives the same name to iron which has been excessively heated and exposed *after balling* in the puddling furnace. It is worthy of remark that no amount of heat applied to the iron in the blast furnace or in the early stages of the puddling process produces burnt iron.

Burnt iron is brittle, its fracture is short and what is called crystalline; it has lost the fibrous character and silky appearance of good iron.

If steel is raised to a bright-red heat, and suddenly cooled, it is rendered hard and brittle, but this hardness may be modified, and brittleness diminished, by the well-known process of tempering. If, however, the steel be raised to a yellow or white heat, and then be suddenly cooled, it is no longer capable of being tempered by mere re-heating. It remains permanently brittle, and is worthless for the ordinary uses of steel, unless it is again raised to a welding heat, and thoroughly rolled or hammered while hot, and then allowed to cool gradually.

The fracture of burnt steel presents a very "coarse grain." It displays in a marked degree the so-called "crystalline" appearance. A careful examination, however, reveals something beyond a merely crystalline structure; for the facets of the aggregated granules have a more or less conchoidal or rounded form. This has been observed by practical men, and the name of "toad's eyes" has been given to the concavities. As brittleness, and granular or "crystalline" fracture, and even toad's eyes, may be due to other causes, it is sometimes of considerable practical importance to be able to determine whether certain defects of a particular sample of iron or steel are due to original defects of the raw material, or to the carelessness of the workman, who may have burned the iron or steel in subsequent stages of working.

When engaged as chemist to large iron works I was

very anxious to be able to solve this question, but for a long time was unsuccessful. Karsten's theory, attributing the change to the absence of carbon, was shaken by the case of the burnt steel. This was also the case with the obvious explanation that the burning is due to oxidation.

An accident finally removed a portion of the theoretical difficulty, and, at the same time, suggested a practical method of testing for burnt iron.

An important part of my laboratory duty consisted in determining the percentage of carbon in Bessemer steel. Each blow was thus examined daily. Besides determining the carbon of the raw ingots, I frequently had to do the same for samples of rails, plates, tyres, and miscellaneous samples of manufactured steel. As many as thirty or forty of such determinations were frequently made in one day.

On one occasion, a trap was laid to catch the chemist, by an excessively "practical" man, who was displeased by the detective revelations of the laboratory. Two samples of borings, marked A and B, were sent for the carbon of the "*steel*" to be determined. My assistant reported that neither contained more than a trace of carbon,—that neither sample was steel, but both were iron. I then examined them myself, and observed that they behaved very differently on the application of the standard nitric acid used for solution.

When the acid was applied to sample A, the liquid at first became unusually dark, suggesting a very large proportion of carbon. This colour gradually became less marked, and, finally, disappeared altogether, and when the solution was completed I found no indications of carbon at all. Sample B behaved in the usual manner of good iron, and only indicated a small trace of carbon—too small to be quantitatively determined by the colour test.

Suspecting the presence of oxide in sample A, I repeated the experiment more carefully, and then observed that the dark colour of the liquid was due to suspended particles, kept in suspension by the effervescence, and that these particles were finally dissolved.

Further examination proved that they were particles of oxide of iron entangled amidst the metallic iron. On enquiry I learned that the samples were borings taken from the opposite sides of an armour plate, one side of which was burned, and the other side good. Sample A was from the burnt side.

I afterwards obtained samples of iron burnt in different degrees, from such as were just perceptibly damaged, to others that were quite rotten, and I found that, in all cases, there was a small quantity of oxide in the burnt iron, and that I could readily detect it by the very simple method of putting the borings into a nitric acid diluted to the specific gravity of 1·20. The burnt iron always gave a dirty appearance to the acid, which afterwards disappeared. This appearance is quite different from that presented by the acid in which similar borings of good iron have been placed. With a little practice in observing the normal appearance of good iron, and by using similar borings, the difference is easily detected, and thus a valuable practical laboratory test for burnt iron is afforded.

This test is only applicable to borings from samples of clean finished iron, the silicon, graphite, and other impurities of pig-iron produce a similar dirtiness, which might be mistaken for that produced by the oxide. The dark colour produced by combined carbon is so different in its appearance that it is at once distinguishable, besides which this is permanent.

I examined samples of burnt steel in the same manner, but no indications of the presence of intermingled oxide were presented. This, of course, was to be expected, as the carbon of the steel must protect it more or less completely from oxidation by heat. It thus appears that, although the mechanical peculiarities of burnt iron and burnt steel so nearly resemble, the respective chemical changes effected in the so-called burning are quite different.

A number of other facts go to show that the burning of burnt iron is simply a process of partial oxidation and that therefore the term "burnt iron" is philosophically correct. An armour plate, for example, is made up of a larger number of balls or blooms of puddled iron welded together. It is built up by welding puddled balls with slabs, slabs into moulds, and piling and welding these moulds into plates. These processes include several re-heatings of the iron, and at each re-heating the whole of these great masses of iron must be raised to a full welding heat.

The rolling of a 4-inch plate was formerly declared by all practical men to be an impossibility, until a remarkably enterprising man, then scarcely aware of the difficulties to be overcome, undertook to do it, and succeeded, not only in reaching the four inches, but ultimately progressing to fourteen. One of the greatest difficulties to be overcome was the re-heating of these great masses without burning them, and opportunities of earning large wages were offered to the workmen who should superintend these furnace operations successfully. I know an illiterate black-faced workman, one of the pioneers in this enterprise, who earned as much as £40 per week, by payments received on tonnage of work done under his direction, and have watched with great interest the mode of proceeding of this man and others who have successfully conducted such furnace operations. By various devices, the philosophy of which they do not dream of understanding, they subject the iron to the action of a *reducing* flame only. I have peered into these great reverberatory furnaces or ovens at all stages, scorching my face, and inflaming my eyes continually, and, except at quite the early stage of the re-heating, or the preparatory stages of heating the oven walls, have always found a densely carbonaceous, obviously reducing flame to be the only one permitted to play upon the iron.

One device I may specially mention on account of its simplicity, universality, and effectiveness. The great doors of the reverberatory chamber, through which the iron is introduced and withdrawn, are made to rise and fall by the action of a counterpoised lever. They are frequently opened to examine the state of the pile, and do not fit closely. There is considerable air space at the bottom. If this were left open, a supply of oxygen would find its way to the iron within. Without any idea of the philosophy of the practice, the workman places large lumps of coal just inside the doors in such a position that the entering air must pass them before they can reach the iron. This coal, intensely heated by radiation from the great flame, and the white-hot furnace walls, is prepared to combine with more than all the oxygen that can enter, which thus passes forward as carbonic oxide and aqueous vapour.

I have made similar observations in other processes of iron working; thus, when the puddler has called up his charge, *i.e.*, when it is no longer protected from oxidation by its own combined carbon, he closes his damper, and fills up the air-ways of his furnace *with lumps of coal*. He does this most carefully, just at the time when oxidation would be mischievous. He knows nothing about the theory of this admirable device, and, as far as I have learned, no chemist has hitherto explained the philosophy of this carbon door, and why the puddler, instead of using an ordinary furnace door so easily applicable, always has an iron ledge or shelf fixed in front of his fire hole, on purpose for thus blocking it up with coal. The "stuff hole" is also carefully stuffed with coal at the same time.

Thus, it appears, that when iron is unprotected by combined carbon, it is oxidised not merely on its surface but through its whole substance, if exposed at a sufficiently high temperature, and for a sufficient length of time to the action of atmospheric oxygen. The possibility of such internal oxidation no longer presents a difficulty, the researches of Deville, Troost, and Graham having proved that red-hot iron is permeable by certain gases.

The Bessemer process illustrates the protecting action of combined carbon in a very striking and interesting manner. Mr. Riley mistakes in supposing that weldable

Bessemer iron contains no carbon. I have made repeated analyses of Bessemer metal in which the carbon is reduced to the lowest proportion compatible with coherence, and find that this limit is reached when the carbon is reduced to about 0·2 per cent in Bessemer metal prepared in the usual manner. The general practical limit is 0·25 per cent.

This is well known to all practical manufacturers who are at all acquainted with the chemical composition of their steel.

With less than 0·2 per cent of carbon, the Bessemer iron crumbles under the hammer, and if nearly free from carbon, it behaves like a piece of coarse sandstone. This is the ordinary condition of the iron at the termination of the "blow," and before the speigeleisen is introduced. It is then a burnt iron of very exaggerated type, and is quite useless until it has been unburnt by the carbon of the speigeleisen.

The introduction of the speigeleisen displays in a very beautiful manner the presence of the intermingled oxide. When the fused speigeleisen is poured into the converter containing the fused material, which I shall call the melted burnt iron, a violent ebullition is visible, jets of carbonic oxide are forced through this burnt iron, and a huge blue carbonic oxide flame pours out of the mouth of the converter. The quantity thus poured forth fills completely the mouth of the converter; it is perfectly obvious that no air is entering at the same time, the blowing has ceased, and thus the only possible source of supply of oxygen for the formation of this great volume of carbonic oxide is within this melted burnt iron. If the quantity of speigeleisen thus introduced is insufficient to supply a minimum surplus of 0·20 to 0·25 per cent of carbon, the reduction of the free oxide is not completed, and the resulting product breaks under the hammer from mere want of complete coherence.

In like manner, when the spongy balls of iron from a puddling furnace are first crushed down by the hammer, jets of carbonic oxide (to which the workman applies the universal name of "sulphur") issue forth. I have observed that this takes place most abundantly when the ball has stood for some time waiting its turn for the hammer, and believe that it is caused by the commingling of the superficial burnt iron with the inner iron which remains unburnt, and still retains a small portion of carbon.

The manufacture of pure iron by the ordinary processes is practically impossible, for immediately all the carbon is gone oxidation commences, and iron quite free from carbon will not bear the exposure which is necessary in the processes of forging, still less of fusing. By working in an atmosphere of carbonic acid, pure iron might be obtained.

The amount of carbon necessary to prevent the iron from becoming burnt varies with the severity of the oxidising exposure. The case of the Bessemer iron above cited is that of the maximum severity of exposure. The idea sometimes expressed that chemically pure iron would be unfit for commercial purposes is, I believe, a great fallacy. The nearer it approaches to purity the greater its value for all purposes where toughness, malleability, and ductility are demanded. The great art of producing good armour-plates is that of working exactly up to the point where the carbon is reduced to its uttermost minimum, and where another re-heating, even to bright redness, would produce burnt iron, the iron being also free from other impurities, especially phosphorus.

I have already shown that burnt steel does not contain the free oxide which by its presence destroys the continuity and cohesion of burnt iron. What, then, is the nature of the burning process in this case, and how does it produce the observed mechanical changes? The following facts may assist us to the required explanation.

When engaged at the works of Sir John Brown and Co., at Sheffield, I frequently had to determine the carbon of rails, tyres, plates, &c., made from known samples of Bessemer steel, from ingots of which I had already determined and recorded the percentage of carbon. In every case, where I had reliable opportunities of identifying the raw material, I found that the finished rail, &c., contained less carbon than the ingot from which it was made. The amount of difference, however, was variable—was usually the greatest when the steel was the hardest, *i.e.*, when it contained the largest proportion of carbon. This reduction of the quantity of carbon varied from 0·02 to 0·10 per cent. The extreme of these limits was reached in the case of some hard steel plates, which, on account of their excessive hardness, were objects of special investigation.

Now, the steel of these plates, or the ordinary rails, &c., are only heated to bright redness, then hammered, heated again, and rolled.

Another case. Some very brittle plates were made by rolling an unusually hard sample of Bessemer steel, containing 0·75 per cent of carbon. Being engaged in some experiments on annealing, I secured some pieces of this plate, and heated them for periods varying from six hours to four days in an annealing furnace where the temperature was purposely retained at a dull red heat. I then examined them mechanically and chemically—determined the carbon of their "skin" and of their interior at different depths from the surface. By the skin, I mean the clean metal surface, after the scale was removed. This skin was shaved off for analysis by means of a flat-faced drill.

I found that the skin of the piece of plate that had been heated during four days contained no carbon, or only a trace too small for determination, that this absence of carbon continued to a sensible depth, to about the fiftieth of an inch. (Having no means of accurate measurement, this estimation is but an approximation). Below this, a sensible amount of carbon was detected, and this rapidly increased till, at a depth of about one-eighth of an inch, it amounted to 0·72 per cent, and this without any sensible variation continued to the middle of the plate (which was half-inch thick), and on to within about one-eighth of an inch of the other side.

All the other plates suffered a loss of carbon from their surface, but in lesser degrees, corresponding to the time to which they had been heated.

I made several repetitions of such experiments, and found that, by exposing steel to open fires, the removal of the carbon from its surface and interior was much more rapidly effected. I do not bring forward these experiments as novelties, as I believe that similar experiments have been made by others. They show that the carbon of steel may be oxidised and removed without fusion or *visible* combustion; that a slow combustion of carbon takes place even at a low red heat, and that this combustion, like the opposite process of cementation, is not limited to the surface, but proceeds gradually inwards.

The permeability of red-hot steel by oxygen and carbonic oxide enables us to understand the otherwise mysterious action of the interior oxidation of the carbon. Under favourable circumstances, it is probable that a considerable portion of the carbonic oxide thus produced may remain occluded in the iron.

Let us now suppose that we have a piece of steel at the welding or pasty heat, just at the temperature most favourable for the most rapid endosmosis of oxygen and the exosmosis of carbonic oxide, and that while these actions are in full progress, we suddenly cool the steel, and arrest the possible occlusion of the carbonic oxide. The result would be the production of a certain degree of molecular disintegration, and porosity of the steel, the minute arrested bubbles of carbonic oxide or oxygen producing a similar effect upon the cohesion of the burnt steel, and that of the particles of oxide upon the burnt iron.

The "toad's eyes," or conchoidal facets of the so-called crystals, are in strict accordance with this explanation, as also is the fact that burnt steel may be cured by re-heating and hammering, or rolling at a welding heat, as at this temperature, and subjected to such pressure, the separated faces of the bubble holes would be welded together, and the gases either occluded or driven out.

All steel presents a "grain" or so-called crystalline

structure, and this varies in its degree of coarseness. In ordinary hardened steel the grain is coarser than in the same quality of steel when tempered or softened.

My own conviction is that all steel and all iron is of spongy structure, that such a structure may even be common to all metals, that the so-called crystalline fracture of iron and steel is not due to crystallisation at all, but to a visible degree of porosity, and that the fibrous structure of rolled iron is merely due to a different arrangement, an elongation of these mechanical pores. By pores and porosity I do not mean those imaginary interspaces between imaginary atoms in the midst of which our modern mathematicians so luxuriously revel, but actual, visible, and demonstrable spaces.

A further statement of the grounds upon which this view of the constitution of metals is based would carry me beyond the proper limits of this paper, and, therefore, with the permission of the President and Council, I will bring this subject before the Society on some future evening.

Communications from the Laboratory of the London Institution. No. I. "On the Formation of Sulpho-Acids." By HENRY E. ARMSTRONG.

Occupied with an investigation into the constitution of sulphuric acid, the views on which are, as is well known, even at the present moment, extremely conflicting, my attention was soon drawn to the body discovered by Professor Williamson—viz., chlorhydric sulphate (sulphuric chlorhydrate, sulphuric oxychloride), SO_2HOCl, and particularly by a somewhat remarkable reaction noticed by Karl Knapp,* who found that the chief product of its action on benzol was sulpho-benzid, sulpho-benzolic chloride and sulpho-benzolic acid being formed, but in relatively very small quantity.

$$2C_6H_6+SO_2HOCl=\left\{\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\right\}SO_2+OH_2+HCl.$$

$$C_6H_6+SO_2HOCl=SO_2C_6H_5Cl+OH_2.$$

$$C_6H_6+SO_2HOCl=C_6H_5SO_2HO+HCl.$$

Whereas it was presumable that sulpho-benzolic acid would be the main product, the reverse was the case!

This led me to commence a series of experiments to determine, if possible, the conditions under which the one or the other of the above reactions took place, and to arrive at a general expression for the action of chlorhydric sulphate on organic bodies.

Action of SO_2HOCl *on Brombenzol*, C_6H_5Br.—Monobrombenzol, 1 eq., diluted with carbonic disulphide, was mixed with the chloride, 1 eq.; moderate reaction took place, HCl being evolved in quantity. After warming on the water-bath for a short period, the CS_2 was distilled off, and the product mixed with water; a brownish, semi-solid mass separated out, and was removed by filtration; the filtrate was neutralised by baryta-water, and heated to boiling, whilst a current of CO_2 was passed into it to remove excess of baryta. On cooling, a difficultly soluble barium salt crystallised out in magnificent white iridescent plates, which were pressed and dried between bibulous paper and analysed.

1·4032 grms. lost 0·035 grm. on drying at 100° = 8·6 per cent OH_2.

0·4494 grm. dry salt gave 0·1723 grm. $BaSO_4$ = 22·5 per cent Ba.

These numbers correspond well with the formula $(C_6H_4BrSO_3)_2Ba+3aq.$, which requires 8·1 per cent OH_2 and 22·6 per cent Ba.

The portion insoluble in water was washed with cold alcohol, to free it from adhering brombenzol, and then dissolved in hot alcohol; on cooling, it crystallised in fine, long, white, glistening needles, which, after pressing and drying at 100°, were analysed, with the following results:—

0·4271 grm. gave 0·607 grm. CO_2 and 0·0974 grm. OH_2 = 38·7 per cent C and 2·5 per cent H.

The formula— $\left\{\begin{matrix}C_6H_4Br\\C_6H_4Br\end{matrix}\right\}SO_2$ (dibrom-sulpho-benzid), requires 38·3 per cent C and 2·1 per cent H. When dry, this body forms white silky needles, soluble in hot, difficultly soluble in cold, alcohol; it melts at 168°, and solidifies again at 149°.

The action on brombenzol is, therefore, somewhat different to that on benzol; bromsulpho-benzolic acid is the main product, the yield of dibromsulpho-benzid not exceeding 20 per cent. Bromsulpho-benzolic chloride was formed, if at all, in but very small quantity.

Whether the bromsulpho-benzolic acid thus obtained is identical with that prepared by the action of concentrated sulphuric acid on brombenzol I cannot state, not having compared them directly.

Action of SO_2HOCl *on Nitrobenzol*, $C_6H_5NO_2$.—The two were mixed, as before, in the proportion of 1 eq. of each, but without the addition of CS_2. In this case the action was extremely sluggish, and it was only after long-continued warming that the evolution of HCl ceased. On mixing with water, a small quantity of a black, tarry mass remained, which may possibly contain dinitro-sulpho-benzid. The solution was converted into the barium salt; but, as this was exceedingly impure, it was dissolved, together with a quantity of baric hydrate, and the solution saturated with hydrogen sulphide. After boiling the solution, the barium was carefully precipitated by SO_4H_2, and the filtrate evaporated to crystallisation. By this means, the very impure nitro-sulphobenzolic acid first formed was reduced to the amido-acid, which could more easily be purified.

According to Schmitt,* by the action of concentrated sulphuric acid on nitrobenzol, and reduction of the product to the amido acid, an amido-sulpho-benzolic acid is obtained isomeric with sulphanilic acid, prepared from concentrated sulphuric acid and amido-benzol (aniline). His acid crystallises with 1½ molecules aq., sulphanilic with one molecule only. My product, I believe, is not sulphanilic acid; it is much too soluble in water, and crystallises differently; but, on the other hand, it crystallises with one molecule aq. only:—

1·2555 grms. lost 0·1153 grm. = 9·1 per cent OH_2.

$C_6H_4NH_2HSO_3+aq.$ requires 9·4 per cent; so that, until it has been compared directly with Schmitt's acid, it is impossible to say with certainty whether, by the action of SO_4H_2, and of SO_3HCl, on nitrobenzol, the same, or isomeric, sulpho acids are produced.

Action of SO_2HOCl *on Nitrophenol*, $C_6H_4NO_2HO$.—Nitrophenol (the volatile modification, melting-point 45°), 1 eq., mixed with CS_2, was mixed with 1 eq. of the chloride; immediate action took place, and large quantities of HCl were evolved. After distilling off the CS_2, the product was entirely soluble in water.

The excess of sulphuric acid was removed by $PbCO_3$, the excess of lead by SH_2, and the solution then neutralised with potassic carbonate and evaporated to crystallisation. In this way, the very characteristic yellow needles of the di-potassic nitrophenol-sulphate—

$$C_6H_3NO_2OKSO_3K+2aq.$$

were obtained; and from a solution of this salt, on the addition of acetic acid, the tufts of light yellow needles of the potassic nitrophenol-sulphate, $C_6H_3NO_2OHSO_3K$.

Very remarkable is the action of the chloride on the non-volatile modification of nitrophenol. According to Kekulé, whereas the volatile modification is readily converted into the sulpho acid by the action of concentrated sulphuric acid, it is not possible to prepare a sulpho-acid from the isomeric, non-volatile modification. The same nitro acid was prepared by Kolbe and Gauke, by nitration of paraphenol-sulphonic acid; they could not, however, obtain a nitro acid by the action of nitric acid on metaphenol-sulphonic acid. I had hoped to obtain such an acid by the action of SO_2HOCl, but it is not so.

When mixed in equivalent proportions, with the addition of CS_2, immediate action takes place, and large quantities of HCl are evolved. On the addition of water, an oil separated, which dissolved almost entirely in hot water;

* *Zeitschrift für Chemie*, 1869, 41.

* *Ann. Chem. Pharm.*, vol. cxx., p. 163.

but from the solution, on cooling, the characteristic long white needles of nitrophenol crystallised out. The filtrate contained only sulphuric acid and traces of nitrophenol.

The sulpho acid, if formed—and it seems to me beyond doubt that it is—in the first instance, is evidently decomposed by water into nitrophenol and sulphuric acid.

It may, perhaps, be possible to isolate it by appropriate treatment.

Action of SO_2HOCl *on Naphthaline.*—1 eq. naphthaline, dissolved in CS_2, was acted on by 1 eq. SO_2HOCl; violent action took place, accompanied by evolution of HCl. The reaction was terminated, after distilling off the CS_2, by heating for some time at 100°. The residue remaining, after treatment of the product with water, consisted almost entirely of naphthaline, since it was volatilised on boiling with water. The naphthaline compound, analogous to sulpho-benzid, is, therefore, not formed in any appreciable quantity. From the aqueous solution a barium salt was obtained containing 24·4 per cent of barium. Baric sulpho-napthalate requires 24·7.

To decide, if possible, whether both the α and β modifications of sulphonaphthalic acid were formed, the calcium salt was prepared and a determination of the water of crystallisation made. The β salt is anhydrous, whereas the α salt crystallises with 2 molecules aq., corresponding to 7·3 per cent; my salt contained 3·6 per cent, and, I believe, therefore, was a mixture of the two isomeric salts. In all probability, the α acid first formed is converted by subsequent heating into β acid. The anhydrous Ca salt contained 8·8 per cent Ca; required, 8·7 per cent.

By the action of 2 molecules SO_2HOCl on 1 molecule naphthalin a disulpho-acid is formed.

The conclusion to be drawn from the above few experiments is, it seems to me, the normal action, so to speak, of SO_2HOCl is to form a sulpho-acid, the Cl of the chloride removing H from the body acted upon and replacing it by the group SO_3H; it is only under certain conditions that both Cl and HO are removed from the chloride, and a sulphobenzid analogous compound formed. What these conditions are I hope to establish by a further more extended series of experiments.

"*On a Water from the Coal Measures at Westville, Nova Scotia.*" By Professor How.

In a paper published in the *Journ. Chem. Soc.* for May, 1870, I described an acid water from the Acadia coal mines at Stellarton, Pictou County, Nova Scotia. The subject of the present communication was obtained from a neighbouring mine in the same county, the Black Diamond Colliery, situated at Westville, a new village about 2 miles west of the former place. This water differs from that got at Stellarton, which was partly of surface origin, in having been taken from a coal-pit; and while that furnished a good illustration of the evils attending the use of such a water in boilers, this gives an opportunity of comparing a water from the productive coal measures with those arising under different geological conditions. In 1865, I described to the Society (*Journ. Chem. Soc.*, vol. xviii., p. 44) a dense brine from Salt Springs, Pictou County, which, though containing more salt than the others, as yet ascertained, probably shows the general character of the brines issuing from the lower carboniferous gypsiferous districts of this province, since it agrees with another of them, from Walton, a distant locality, as I have shown (*Trans. N. S. Inst.*, 1865; and "Mineralogy of Nova Scotia," p. 143), in containing sulphate of calcium as the most abundant ingredient after chloride of sodium, and smaller quantities of chloride and carbonate of magnesium and calcium, though the amounts of these are not alike, either absolutely or relatively. There are other waters arising in these gypsiferous districts in which sulphates are the chief constituents, chlorides being nearly absent. For example, the Spa Spring water of Windsor, Hants County, contained, when I analysed it in 1858, solid matter in the imperial gallon to the amount of 138 grains, of which about 106 were sulphate of calcium, 12 consisted of sulphates of magnesium, sodium, and potassium, and only 0·9 of any chloride, that of sodium (CHEMICAL NEWS, vol. ix., p. 98). These eminently sulphated waters present interesting contrasts with those in which chlorides are by much the preponderating constituents, as the saline water of Bras d'Or, Cape Breton, analysed by myself (CHEMICAL NEWS, vol. ix., p. 97); the brines of Onondaga, New York, examined by Professor Gössmann (*Silliman's Journal*, July, 1867); several others described by Dr. Hunt ("Geology of Canada," 1863, p. 53; and "Contributions to the Chemistry of Waters," *Silliman's Journal*, 1865); and the Wheal Clifford water, analysed by Professor W. A. Miller (CHEMICAL NEWS, vol. x., p. 181), and also with the Kissengen water at Harrogate, examined by Dr. S. Muspratt (CHEMICAL NEWS, vol. xiv., p. 49, and xv., p. 245); and those described by Dr. Hunt (*loc. cit.*), in which chlorides are abundant and sulphates are absent. All these waters, excepting that from Harrogate, which is from rocks at the junction of the permian with the carboniferous, issue from systems older than the carboniferous, and we see the same features presented by waters of intermediate times, for the brines of the valley of the Alleghany river, obtained from borings in the coal formation, are remarkable for containing large proportions of chlorides of calcium and magnesium, though the sum of these is never equal to more than about one-fourth of the chloride of sodium. The presence of salts of barium and strontium in these brines, and the consequent absence of sulphates is, according to Linney, a constant character in this region over an area of 2000 square miles (Bischof, "Chemical Geology, vol. i., p. 377). In this curious circumstance, these waters agree with the Kissengen water and several of the Canadian waters described (*ubi supra*) by Dr. Hunt.

The water now to be described was mentioned as having been taken from the productive coal measures. These constitute the middle coal formation, or the coal measures proper, of this province, according to the arrangement of Dr. Dawson, who says that this series includes the productive beds of coal, and is destitute of properly marine limestones. Beds tinged with peroxide of iron are less common in this formation than in any of the others of the system. Dark-coloured shales and grey sandstones prevail, and there are no conglomerates ("Acadian Geology," 2nd edition, p. 130). These beds are separated from the gypsiferous group before referred to by the underlying millstone grit series, and they represent the lower coal measures of the United States, and in part the coal formation of Great Britain.

Two samples of water were taken from the same pit at the Black Diamond Colliery under somewhat different circumstances, and sent to me for examination, in November, 1870, by A. W. Greig, Superintendent of the Nova Scotia Coal Company, who was desirous of ascertaining whether the water would answer for use in his boilers. The waters were bright and clear, they had no odour, their taste was that of good spring water; they gave, respectively, the following results:—

	Grains in the imperial gallon.	
	No. 1.	No. 2.
Silica	0·63	0·46
Carbonate of calcium	11·55	10·59
,, magnesium ..	3·67	3·57
,, iron	traces	traces
Chloride of sodium	0·84	1·17
Sulphate of potassium	1·14	1·58
,, sodium	4·17	2·50
Phosphoric acid	none	none
Organic matter	none	traces
Carbonate of sodium	3·55	3·35
	25·55	23·22
Free carbonic acid	undetd.	undetd.
Specific gravity	1000·459	1000·339

Hence it appears that the waters were essentially the same. They had an acid reaction on litmus, the paper regained its blue colour on drying, they gave off a good deal of carbonic acid gas, and deposited carbonates of calcium and magnesium on boiling. After two or three hours' boiling, nearly all the calcium was thrown down, and on concentration a mere trace remained dissolved. The waters soon acquired an alkaline reaction on evaporation; when concentrated, they coloured turmeric deep brown, effervesced with acid, and contained sulphates, alkalies, and a notable quantity of magnesia.

The waters, being one and the same, may be spoken of as the water from Westville, and, of course, in reference to the condition after loss of the carbonic acid, which renders the carbonates present bicarbonates, as an alkaline water. It is interesting to find the composition of this water so totally unlike that of any of the waters of this province yet analysed, though this was to be expected, considering the different geological conditions under which they have been examined. The small quantity of chlorides may have some relation to the absence of marine limestones in the productive measures mentioned by Dr. Dawson, and is in very strong contrast with that in the brines from the coal formation of the Alleghany River district referred to above. In the waters containing carbonate of sodium, analysed by Dr. Hunt, which form his fourth class (*loc. cit.*), chlorides are sometimes absolutely and relatively more abundant than in this case, but, on the whole, this is the class to which the Westville or Black Diamond Colliery water belongs.

NOTICES OF BOOKS.

Select Methods in Chemical Analysis (Chiefly Inorganic). By WILLIAM CROOKES, F.R.S., &c. London: Longmans, Green, and Co., 1871.

IT will be perceived from the title of this work that the author has not intended to provide the student with a complete text-book of analysis, but rather with a laboratory companion, containing information not usually found in ordinary works on Analysis. The book is essentially a reprint of the important articles on inorganic chemistry in the first twenty volumes of the CHEMICAL NEWS, verified, condensed, and arranged in proper order; and as some of these have proved to be of great value, it was thought that a service would be rendered to analytical chemistry if these trustworthy methods of analysis were systematically arranged in a convenient form for laboratory use. In some instances the descriptions are given in the language of the original writer, but in all cases where the author has improved the processes, the necessary modifications have been introduced.

It is strange that modern works on analysis should ignore about twenty of the elements. Even Fresenius gives only a separate form for their detection. Were investigators more in the habit of looking for the "rare" elements, they would no doubt turn up unexpectedly in many minerals. In this work equal prominence is given both to the rare and to the ordinary elements.

The order in which the analytical separation of the metals is carried out will be readily understood. Take, for instance, the case of copper. After giving the best method for the detection and quantitative estimation of this metal, comes a description of the processes for separating it from those metals which have been previously passed under review, as mercury, silver, and zinc; but no attention is paid to the separation of copper from such metals as lead, tin, &c., which have not previously been treated of. Under the respective headings "Lead" and "Tin," the separation of these metals from copper is described.

A complete list of separations has not been attempted. Where no process of separation or estimation is given, it may be inferred that the author has had no experience in any but the well-known methods employed in most laboratories; and to have introduced these ordinary processes into the work simply for the sake of filling up gaps would have largely increased its bulk without adding materially to its value. To save space, the description of a process is frequently discontinued at the point where the substances under separation are brought to such a state that the concluding steps are obvious.

No special system of weights and measures has been employed; many of the descriptions having been condensed from the original memoirs, it was thought better to retain the system therein adopted, so as to have simple numbers to deal with, instead of having to convert them to one common scale and to introduce decimals; thus—when an author says take 8 grains of a substance, 0·51816 gramme has not been substituted; and where 10 grammes are mentioned, he has not put 154·3840 grains. When not otherwise expressed, all degrees are according to the centigrade scale. Formulæ have been avoided as far as practicable.

CORRESPONDENCE.

COMMERCIAL ANALYSIS.

To the Editor of the Chemical News.

SIR,—I am very glad that Mr. Purser has taken up the subject of commercial analysis as regards one of the commonest substances sold by analysis, namely "superphosphate of lime."

I have been extremely puzzled on many occasions by the discordant results obtained on a well-prepared sample sent to three or four of the leading analysts in the country. In a previous communication to you, on the so-called "reduced phosphates," I advocated the plan that a definite process should be adopted among all commercial analysts, for soluble phosphates, so as to obviate the anomalies which now exist and which tend to bring the practice of commercial analysis, to say the least of it, into ridicule. I would again urge upon those concerned to do away, if possible, with the disgraceful distinction of a "buyer's" and "seller's" analysts. A case occurred to myself a few days ago, in which a sample was well prepared, and divided into two parts, then sealed up in tins, and sent to two well-known men. One reported 21·39 per cent soluble phosphate; the other 26·36. The low report I proved most conclusively to be the correct one. The manure, however, was sold by the analysis, which gave 5 per cent more, and consequently the buyer was requested to pay fifteen shillings per ton more for it than it was worth. Hoping you will lend your aid to the destruction of this system. I am, &c.,

FRANCIS SUTTON.

Norwich, April 17, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Les Mondes, March 16, 1871.

Annuaire du Bureau des Longitudes.—The publication of this small, but extremely useful volume (the eightieth) of a collection not so sufficiently known as it deserves to be, is announced with a few words. The price is, as usual, about two francs; the publishers are MM. Gauthiers-Villars, 55, Quai des Augustins, Paris.

Photographic Post.—Rev. F. Moigno.—This lengthy paper contains an account of this ingenious and useful application of science made during the late siege of Paris.

Urtica Tenacissima.—Dr. Dudouy.—The author, an agriculturist and landed proprietor, states that the plant just named, from which a textile fibre is prepared known under the name of *Ramié* or *Ramaï*, is now successfully cultivated in a portion of Southern France, and also in Algeria. The plant is a native of Java, and a variety of the *Urtica nivea*, which produces the fibre known as China grass. The author states that, from some few experiments made, he is of opinion that this plant, the *Ramié*, might be advantageously grown in the more northerly parts of France. The fibre obtainable from the *Urtica tenacissima* is highly valued for the weaving of fine fabrics—muslins, poplins, &c.—while the remainder of the plant yields excellent fodder for cattle.

Preservation of Potatoes.—Rev. F. Moigno.—The tubers, after having been dug up, which operation should not be done before they have attained proper maturity, may be readily preserved in a sound state by any of the following means:—The tubers are put in pits dug in the soil, and mixed with either charcoal powder, gypsum, ash of coal, peat, or wood, and then kept from the action of direct sunlight, and buried at least half a metre, better 2 metres, under the surface, care being taken that there is proper drainage for water, and some straw placed in the pits.

Leaves of Fir-Trees (Pinus kinds) as Food for Sheep.—V. Chatel.—The young soft twigs of the various species of *Pinus* may, according to experiments made by the author, be mixed with the food of sheep in moderate quantity, being for these animals a healthy stimulant.

Signals for Communication between Fortresses and Distant Armies.—Dr. Le Verrier.—This brief abstract calls attention to a lengthy paper containing the record of a series of experiments made for the Chief Committee of Defence of the Valley of the Rhône, Lyon, for the purpose of communicating, by luminous signals, at distances of 30 to 100 kilometres. It appears that, under the guidance of the well-known *savant* just named, excellent results have been obtained, and so simple in execution that ordinary workmen can satisfactorily manage the signals. The rather considerable expenses of these researches have been defrayed by a private individual, M. Maistre, of Villeneuvette, near Clermont, Hérault.

Sudden and Spontaneous Opacity of the Gas Used to Fill Air Balloons.—Dr. de Fonvielle.—It appears that aëronauts have frequently observed a phenomenon which they term as *le ballon fume sa pipe*—that is to say, the issuing of the gas the air balloon is filled with from the lower opening of the balloon in the form of a whitish smoke. The author supposes that this phenomenon is due to the cold produced by the increase of the volume of the balloon while rising rapidly upwards. Indeed, for a decrease of pressure of 1 millimetre per second of time, the increase of volume is equivalent to that produced by an elevation of temperature of two degrees for a height where the mean pressure would be 660 millimetres of mercury. A similar phenomenon takes place in every instance of the rapid rising of a mass of humid air, which, while becoming dilated, does as the balloon and *fume sa pipe*—that is to say, leaves behind it, in the shape of more or less dense cloud, the watery vapour which it contained previously in the shape of a diaphanous invisible gas.

Moniteur Scientifique, March 1 and 15, Nos. 341 and 342 (double number), 1871.

Review of the Principal Labours of the Late Dr. Pelouze.—Professor J. Dumas.—This lengthy memoir is, notwithstanding its very great intrinsic value, not well suited for any useful abstraction.

Preservation of Raw Butchers' Meat, Fish, Vegetables, Eggs, and other Food by means of Phenicated Water at from one-half to 4 and 5 per cent, according to the Length of Time and the Climate wherein the Preservation is Desired.—Dr. G. Déclat.—The process employed by the author is simple in its execution, since it only consists in first immersing, for some length of time, of the substances alluded to in aqueous solutions, of varying strength, of perfectly pure carbolic acid, and next drying the materials. The process has been tried, and found successful of late, in Paris, with various foods, including vegetables.

Preservation of Meat and other Animal Substances.—E. Pelouze.—The meat, or other animal substance, first cut into pieces of a convenient and not too large size, is introduced into an apparatus wherein it is kept for some time in an atmosphere of carbonic oxide gas under some pressure; and next, the material so treated is dried in a current of dry cold air, so as to remove all traces even of moisture from the substance; after which the meat is superficially treated with an antiseptic solution—either a concentrated brine, or solution of saltpetre or phenicated water—and then packed in hermetically-sealed vessels.

Some Reflections on the State of Science in France: Why did not France find Superior Men at the Time of Danger?—L. Pasteur.—This excellent essay throws prominent light on the disasters which the country alluded to has suffered for the last nine months.

Pigeon Postal Service during the late Siege of Paris.—J. Fleury-Hermagis.—An intelligently written, and, in many respects, valuable paper.

Journal für Gasbeleuchtung und Wasserversorgung, No. 3, 1871.

Hydrostatico-Galvanic Gas Lighter.—Dr. W. Klinkerfues.—From the brief and, as yet, incomplete notice here communicated, it appears that the author, Director of the Astronomical Observatory at Göttingen, has succeeded in contriving an expeditious, automatic, and inexpensive apparatus, whereby the lighting and extinguishing of the gas lights in public lamps becomes automatic and almost instantaneous. Experiments made on sufficiently large scale prove the practicability of this invention, which will be an important improvement in street lighting.

Scientific Hydrotimetry; and on the Necessity of Hydrotimetrical Researches.—Dr. H. Trommsdorff.—This lengthy monograph is valuable to waterworks' engineers and managers; it is not, however, suited for useful abstraction.

Apparatus for Manufacturing Gas from Tar.—M. Craken.—With a woodcut.

Water Supply and Waterworks at Posen.—F. Moore.

Revue des Cours Scientifiques de la France et de l'Etranger, Nos. 42 to 50, inclusive (from September 17, 1870, to March 4, 1871).

These numbers do not contain any original papers or communications bearing upon chemistry and allied sciences.

NOTES AND QUERIES.

Chromates and Phosphates.—Can any of your readers inform me of the names of the manufacturers of chromate of potash (not bichromate), also phosphates of ammonia and of potash; or I would be glad if any maker would send his address to me, under cover to you.—NEMO.

Griffin's "Handicraft."—(1.) Will your readers kindly inform me if Griffin has published any more of his promised Handicraft series—that is to say, any volume besides the "Chemical Handicraft"? (2.) Can they also give me the address of Mr. George Norman, the well-known microscopist of Hull?—S. G.

Ammonia Sulphate from Gas Liquor.—(Reply to "Ammonia.")—Practical information on the manufacture of the above article may be obtained on applying to Dr. Versmann, Chemical Laboratory, 150, Fenchurch Street.

Ammonia Sulphate from Gas Liquor.—If the person who signs himself "Ammonia" in your last week's impression will write to me, giving me the quantity of gas liquor he obtains per week, to be worked into sulphate of ammonium, I will give him, with full particulars, all the practical information he will require—firstly, as to plant, and secondly as to process, &c.—in order to manufacture this salt perfectly white and almost perfectly pure, which may be done as easily and inexpensively as to make it discoloured and impure. I will state my terms when I hear from "Ammonia."—WATSON SMITH, F.C.S., Prestolee Alkali Works, Stoneclough, near Manchester.

Watering Streets.—Your correspondent "C. T." will find H. O. W. Cooper and E. F. Cooper took out a patent for watering streets with "a liquid or composition (of a deodorising nature) mixed with water," and claims the use of salt mixed with deliquescent chlorides, September 2nd, 1867 (No. 2482); but I am not aware if the patent is still in existence, which depends upon whether the requisite £50 was paid on or before September 2nd, 1870, which he can ascertain for nothing at the Patent Office, or through any patent agent for a small fee. Another patent on the same subject is No. 3337, November 26th, 1867; but the plan is different, and it includes "travelling furnaces for liquefying snow."—NEMO.

MEETINGS FOR THE WEEK.

MONDAY, 24th.—Medical, 8.
—— London Institution, 4. Mr. R. A. Proctor, F.R.A.S., "On Astronomy." (Educational Course.)
—— Royal Geographical, 8.30.
TUESDAY, 25th.—Ethnological, 8.
—— Civil Engineers, 8.
—— Royal Institution, 3. William Pengelly, Esq., F.R.S., F.G.S., "On the Geology of Devonshire, especially of the New Red Sandstone System."
WEDNESDAY, 26th.—Society of Arts, 8.
—— London Institution, 12. Annual Meeting of Proprietors.
—— Geological, 8.
THURSDAY, 27th.—London Institution, 7.30. Prof. Bentley, "On Economic Botany."
—— Royal Society Club, 6.
—— Royal, 8.30.
—— Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
FRIDAY, 28th.—Royal Institution, 9. Prof. Odling, F.R.S., "On the Revived Theory of Phlogiston."
—— Quekett Microscopical Club, 8.
SATURDAY, 29th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."
—— Zoological, 1. Anniversary.
—— Quekett Microscopical Club. Excursion to Wandsworth Common; To meet at Clapham Junction at 3 o'clock.

TO CORRESPONDENTS.

W. H. Wood.—Your pamphlet shall be noticed in a future number.
Hugh Burgess, Pennsylvania.—We will communicate with the querist.
P. Holland.—We know of no work of more recent date than Reimann's "Aniline and its Derivatives."
W. H. Walenn.—We are obliged for the communication.
J. S. Skidmore.—Noad's "Quantitative Analysis," recently reviewed in our columns.
J. Blyth.—Thanks for the paper; we shall have great pleasure in inserting it.
Prof. A. Bauer.—Received with thanks.

BOOKS RECEIVED.

Experiments on the Prevention of the Development of Fungi in Aqueous Solutions of Tartaric Acid, and Theories of the Origin of, and Conditions Essential to, Life. By W. H. Wood. Middlesbrough: Burnett and Hood.
The Discovery of the Nature of the Spleen, from an Investigation of the Lateral Homologies of the Liver, Stomach, and Intestinal Canal. By Henry R. Silvester, B.A., M.D. Lond. London: John Churchill and Sons.
Letters on Vaccination. By William Woodward, M.D. Worcester: Deighton and Son.
Second Annual Report of the State Board of Health of Massachusetts, January, 1871. Boston: Wright and Potter.
Preparatory Programme of the National University for Industrial and Technical Training.
On the Composition of the Water of the Irish Sea. By T. E. Thorpe, Ph.D., and E. H. Morton.
A Sketch of Romance of Motion; also a Hypothetical Analysis and Synthesis of Nitrogen. By Alec Lee. London: Longmans, Green, and Co.
Annual of Scientific Discovery: or Year-Book of Facts in Science and Art, for 1871. Edited by John Trowbridge, S.B., aided by W. R. Nichols, and C. R. Cross. Boston: Gould and Lincoln. London: Trübner and Co.

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THE CHEMICAL NEWS.

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CONTRIBUTIONS TO THE HISTORY OF ORCIN.

No. I.—NITRO-SUBSTITUTION COMPOUNDS OF THE ORCINS.*

By JOHN STENHOUSE, LL.D., F.R.S., &c.

THE action of nitric acid upon orcin has been studied by several chemists, but with comparatively negative results. Schunck† in this manner obtained a red resinous substance, which, by further treatment with the acid, was oxidised to oxalic acid; and in 1864 De Luynes‡ found that orcin dissolved in cooled fuming nitric acid without evolution of nitrous fumes, and that the addition of water precipitated a red colouring matter; the long-continued action of the vapour of fuming nitric acid on powdered orcin likewise produced a red dye apparently identical with the above. These, however, were resinous uncrystallisable substances.

Although under ordinary circumstances only resinous products are obtained by treating orcin with nitric acid, yet, when colourless orcin in fine powder is gradually added to strong nitric acid, cooled by a freezing mixture, it dissolves with a pale brown colouration, but without the slightest evolution of nitrous fumes. If this solution be now slowly dropped into concentrated sulphuric acid, cooled to −10° C., the mixture becomes yellow and pasty, from the formation of nitro-orcin, which is but slightly soluble in sulphuric acid. When this is poured into a considerable quantity of cold water, the nitro body separates as a bright yellow crystalline powder, quite free from any admixture of resin.

After numerous experiments, the following was found to be the most advantageous process for the preparation of nitro-orcin:—6 grms. of colourless orcin were dissolved in 6 cubic centims. of boiling water, and when the solution had cooled to about 50° C., it was added in small portions at a time, and with constant stirring, to 40 cubic centims. of nitric acid (sp. gr. 1·45) which was maintained at a temperature of about −10° C. by immersion in a good freezing mixture. The solution, which was of a very pale brown colour, was now added, in a similar manner, to 120 cubic centims. of concentrated sulphuric acid, also maintained at −10° C. The pasty mass, after being allowed to stand for fifteen or twenty minutes in the freezing mixture, was poured into a beaker containing 300 cubic centims. of water and 400 grms. of ice; the crude nitro compound was then precipitated as a yellow or orange-coloured granular powder. The orcin employed in the preparation of this nitro compound was colourless, having been purified by distillation *in vacuo*. The yield of crude nitro-orcin amounted to 150 per cent of the weight of the orcin.

The crude nitro-orcin was collected, washed with a little cold water, and purified by one or two crystallisations from boiling water (40 parts). It was thus obtained in large yellow needles, which are readily soluble in hot water, and but slightly in cold; the addition of a strong acid precipitates almost the whole of the nitro-orcin from its cold aqueous solution. It is soluble in alcohol, very soluble in hot benzol, and crystallises out in great part on cooling; it is less soluble in ether, and but moderately so in bisulphide of carbon. It dyes the skin yellow, like picric acid, but is tasteless. It volatilises slightly at 100° C., melts at 162° C., and decomposes with slight explosion immediately afterwards. When heated with concentrated sulphuric acid, it dissolves, forming a deep yellow solution, which deposits crystals on cooling, and is immediately precipitated by water. It dissolves in hot strong nitric acid, with evolution of nitrous fumes and formation of oxalic acid. Like picric acid, when treated with calcium hypochlorite it yields chloropicrin at the ordinary temperature. Its aqueous solutions are coloured dark brown by ferric chloride, and completely precipitated by lead sub-acetate.

The analysis of the substance dried at 100° C. was made with the following results:—

I. 0·335 grm. of the substance gave 0·400 grm. of carbonic anhydride and 0·062 grm. of water.

II. 0·306 grm. of the substance gave 0·366 grm. of carbonic anhydride and 0·060 grm. of water.

III. 0·525 grm. of the substance gave 0·629 grm. of carbonic anhydride and 0·096 grm. of water.

	Theory.	I.	II.	III.	Mean.
C_7 =	84 = 32·43	32·58	32·63	32·68	32·63
H_5 =	5 = 1·93	2·06	2·18	2·03	2·09
N_3 =	42 = 16·22	—	—	—	—
O_8 =	128 = 49·42	—	—	—	—
	259	100·00			

These results correspond to the formula $C_7H_5(NO_2)_3O_2$, that of trinitro-orcin. It is a powerful acid, much resembling picric acid, but distinguished from the latter by the greater solubility of its salts. I propose, therefore, to call this new substance *trinitro-orcinic acid*.

Potassium trinitro-orcinate.—This was readily prepared from trinitro-orcinic acid by dissolving it in a warm and rather concentrated solution of potassium carbonate. On cooling it solidified to a crystalline mass of fine needles of a deep orange colour, which, after the removal of the mother-liquors by the vacuum filter, or by pressure, was purified by crystallisation from hot water, in which it was very soluble. The salt, dried at 100°, was submitted to analysis.

0·300 grm. of the substance gave 0·155 grm. of potassium sulphate.

	Theory.		
C_7 =	84·0	—	—
H_3 =	3·0	—	—
K_2 =	78·2 = 23·38		23·19
N_3 =	42·0	—	—
O =	128·0	—	—
	335·2		

The result obtained agrees with the formula—

$$C_7H_3(NO_2)_3\Big\}_{K_2}O_2.$$

Sodium nitro-orcinate.—This was obtained by adding nitro-orcinic acid to a strong solution of sodium hydrate or carbonate until nearly neutralised, and purifying by re-crystallisation. It forms orange-coloured microscopic needles, strongly resembling the potassium salt.

Ammonium nitro-orcinate was prepared by adding nitro-orcinic acid to moderately-strong ammonia, in quantity insufficient to neutralise it, boiling for a short time, and then setting aside to crystallise. It forms deep yellow silky needles, which are very soluble in water, but much less so in alcohol.

Barium nitro-orcinate.—Trinitro-orcinic acid was dissolved in 400 or 500 parts of boiling water and an excess of barium carbonate, the pale yellow solution filtered from the excess of carbonate and set aside. On cooling, the solution formed a semi-solid crystalline pap, consisting of fine bright yellow needles of the barium salt. The air-dried salt lost 10·7 per cent at 100°, and became of an orange-red colour, but regained its original colour on ex-

* Read before the Royal Society, March 30th, 1871. A preliminary notice with this title was published in the CHEMICAL NEWS, August 26th, 1870 (vol. xxii., p. 98).

† *Ann. Chem. Pharm.*, vol. liv., p. 270.

‡ *Ann. Chem. Pharm.*, vol. cxxx., p. 34.

posure to moist air. A barium determination was made of the salt dried at 100°.

I. 0·235 grm. of the substance gave 0·139 grm. of barium sulphate.

II. 0·328 grm. of the substance gave 0·194 grm. of barium sulphate.

	Theory.		I.	II.	Mean.
C_7	= 84	—	—	—	—
H_3	= 3	—	—	—	—
Ba″	= 137 =	34·77	34·78	34·79	34·78
N_3	= 42	—	—	—	—
O_8	= 128	—	—	—	—
	394				

The orange-coloured anhydrous salt has the composition—

$$C_7H_3(NO_2)_3 \atop Ba''\Big\} O_2,$$

and the yellow needles—

$$C_7H_3(NO_2)_3 \atop Ba''\Big\} O_2 + 3H_2O.$$

Calcium nitro-orcinate, prepared by neutralising the acid with calcic carbonate, is very soluble in hot water, and crystallises out on cooling in interlaced yellow needles, which are rather soluble in cold water. It is but slightly soluble in hot alcohol, and the solution forms a gelatinous mass on cooling.

Magnesium nitro-orcinate is very soluble in cold water, but less so in spirit. It crystallises in minute orange needles.

Lead nitro-orcinate.—This salt was prepared by dissolving the pure nitro-orcinic acid in 1000 parts of water strongly acidulated with acetic acid, and adding a solution of lead acetate likewise strongly acidulated, when the lead nitro-orcinate came out as a bright yellow crystalline precipitate, consisting of tufts of microscopic needles, which are very tough and difficult to reduce to powder. It is almost insoluble in cold water, slightly in hot; it is soluble in hot acetic acid, from which it crystallises unaltered; it is insoluble in alcohol. If alcoholic solutions of nitro-orcinic acid and lead acetate be mixed, the lead salt is obtained as a yellow amorphous precipitate.

Dried at 100°, it gave the following results:—

I. 0·319 grm. of the substance gave 0·207 grm. of plumbic sulphate.

II. 0·536 grm. of the substance gave 0·348 grm. of plumbic sulphate.

III. 0·339 grm. of the substance gave 0·221 grm. of plumbic sulphate.

	Theory.		I.	II.	III.	Mean.
C_7	= 84	—	—	—	—	—
H_3	= 3	—	—	—	—	—
Pb	= 207 =	44·62	44·34	44·36	44·54	44·41
N_3	= 42	—	—	—	—	—
O_8	= 128	—	—	—	—	—
	464					

Its composition is, therefore, represented by the formula—

$$C_7H_3(NO_2)_3 \atop Pb''\Big\} O_2.$$

Copper nitro-orcinate, formed by dissolving cupric carbonate in a strong aqueous solution of nitro-orcinic acid, was with difficulty obtained in the crystalline state in the form of small reddish-brown needles, which are very soluble in water and alcohol, but are precipitated from their solution in the latter menstruum by ether.

Zinc nitro-orcinate, formed from zinc oxide in a similar manner to the copper salt, is likewise very soluble in water and alcohol, and crystallises in tufts of yellow needles.

Silver nitro-orcinate.—Nitro-orcinic acid was dissolved in fifty times its weight of boiling water, an excess of silver oxide added, and, after boiling a few minutes, filtered from the undissolved silver oxide. On cooling, the whole solidified to an orange-red gelatinous mass of the silver compound, which exhibited no signs of crystallisation. It is moderately soluble in hot water, and its solution gelatinises on cooling. When boiled for any length of time its solution slowly decomposes. Dried at 100°, it gave the following results:—

I. 0·458 grm. of the substance gave 0·277 grm. of argentic chloride.

II. 0·398 grm. of the substance gave 0·241 grm. of argentic chloride.

	Theory.		I.	II.	Mean.
C_7	= 84	—	—	—	—
H_3	= 3	—	—	—	—
Ag_2	= 216 =	45·66	45·47	45·57	45·49
N_3	= 42	—	—	—	—
O_8	= 128	—	—	—	—
	473				

This corresponds to the formula—

$$C_7H_3(NO_2)_3 \atop Ag_2\Big\} O_2.$$

Ethylic nitro-orcinate.—Dry and finely-powdered silver nitro-orcinate was digested with ten times its weight of ethylic iodide until the silver salt was completely decomposed, as shown by the pale yellow colour of the silver iodide formed; the excess of ethylic iodide distilled off, and the ethyl nitro-orcinate extracted from the residue by boiling alcohol, from which it crystallised in bright yellow prismatic needles. One or two re-crystallisations rendered it quite pure. It melts at 61·5° C., and is very soluble in hot alcohol, which, if the solution be concentrated, deposits it as an oil that solidifies on cooling.

The substance dried *in vacuo* was submitted to analysis.

0·189 grm. of the substance gave 0·290 grm. of carbonic anhydride and 0·078 grm. of water.

	Theory.	
C_{11}	= 132 = 41·91	41·85
H_{13}	= 13 = 4·13	4·58
N_3	= 42 = 13·33	—
O_8	= 128 = 40·63	—
	315 100·00	

It may, therefore, be represented by the formula—

$$C_2H_3(NO_2)_3 \atop (C_3H_5)_2\Big\} O_2.$$

Methyl nitro-orcinate was prepared in a manner precisely similar to that above described, substituting methylic for ethylic iodide. Like the ethyl compound, it forms bright yellow crystals, which, however, have a somewhat higher melting-point, viz., 69·5° C.

Trinitro-resorcinic acid.—As it seemed important to ascertain if the homologues of orcin yielded compounds similar to trinitro-orcin, I submitted resorcin to the action of nitric and sulphuric acids in a manner precisely similar to that above described for the preparation of nitro-orcin.

The resorcin employed was prepared from galbanum by the excellent method given by its discoverers, Hlasiwitz and Barth,* substituting, however, sodium hydrate for potassium hydrate. After purification, it was treated with nitric and sulphuric acids, employing the proportions and methods detailed in the preparation of trinitro-orcin. As might have been expected, the yield of crude substance was larger, being 180 per cent of the resorcin employed. It was collected, washed with cold water, and purified by one or two re-crystallisations from boiling water (30 parts). It is of a paler colour than the corresponding orcin compound, and crystallises in leafy plates. It melts at a higher temperature (viz., 175·5° C.), and is more soluble than nitro-orcin; 156 parts of water dissolve 1 of nitro-resorcin at 14° C., but the presence of even a small proportion of one of the stronger acids renders it almost insoluble. Dried at 100° it gave the following results:—

I. 0·384 grm. of the substance gave 0·412 grm. of carbonic anhydride and 0·043 grm. of water.

* *Ann. Chem. Pharm.*, vol. cxxx., p. 354.

II. 0·418 grm. of the substance gave 0·451 grm. of carbonic anhydride and 0·051 grm. of water.

	Theory.		I.	II.	Mean.
C_6	= 72	= 29·39	29·27	29·43	29·35
H_3	= 3	= 1·23	1·30	1·36	1·33
N_3	= 42	= 17·14	—	—	—
O_8	= 128	= 52·24	—	—	
	245	100·00			

This corresponds to the formula $C_6H_3(NO_2)_3O_2$, that of trinitro-resorcin.

Barium nitro-resorcinate was prepared by dissolving nitro-resorcin in 100 parts of boiling water, and adding an excess of baric carbonate. The filtered solution, on cooling, deposited the barium compound in minute rhomboidal plates of a pale yellow colour. It is much more soluble than the corresponding nitro-orcin compound. The crystals contain three equivalents of water of crystallisation, which they do not lose at 100° C.; but, when gently heated on platinum foil, they assume an orange-red colour, from the loss of water of crystallisation, and at a higher temperature explode with extreme violence, perforating the foil. Both nitro-orcinic and resorcinic acids, and their salts, explode with far greater violence than picric acid and its compounds.

A barium determination of the nitro-resorcinate, dried at 100°, yielded the following results:—

I. 0·409 grm. of the substance gave 0·220 grm. of baric sulphate.

II. 0·444 grm. of the substance gave 0·239 grm. of baric sulphate.

	Theory.		I.	II.	Mean.
C_6	= 72·0	—	—	—	—
H_7	= 7·0	—	—	—	—
Ba''	= 137·2	= 31·59	31·63	31·66	31·64
N_3	= 42·0	—	—	—	—
O_{11}	= 176·0	—	—	—	—
	434·2				

The formula is, therefore—

$$C_6H(NO_2)_3 \left\{ Ba'' \right\} O_2 + 3H_2O.$$

Lead nitro-resorcinate.—The addition of a solution of acetate of lead to an aqueous solution of nitro-orcinic acid gave a yellow gelatinous precipitate of lead nitro-resorcinate. It was found best, however, to prepare it by boiling a solution of 1 part of nitro-resorcinic acid in 200 of water, with a slight excess of lead carbonate, when the lead compound was deposited on cooling in the form of deep yellow needles. It is but slightly soluble in water, very soluble in acetic acid, and precipitated therefrom by the addition of alcohol. Sub-acetate of lead completely precipitates solutions of nitro-resorcinic acid.

Silver nitro-resorcinate.—This was prepared in a manner similar to the nitro-orcinate. A solution of 1 part of the pure acid in 75 of water was boiled for a short time with a slight excess of oxide of silver, and filtered. On cooling, the silver salt was deposited in long fine needles of a yellowish brown colour. They crystallise readily from boiling water, in which they are much more soluble than the corresponding nitro-orcinate. Dried at 100°, it gave the following results:—

I. 0·456 grm. of the substance gave 0·284 grm. of chloride of silver.

II. 0·416 grm. of the substance gave 0·260 grm. of chloride of silver.

	Theory.		I.	II.	Mean.
C_6	= 72	—	—	—	—
H	= 1	—	—	—	—
Ag_2	= 216	= 47·07	46·87	47·04	46·96
N_3	= 42	—	—	—	—
O_8	= 128	—	—	—	—
	459				

The analyses correspond to the formula—

$$C_6H(NO_2)_3 \left\{ Ag_2 \right\} O_2.$$

Trinitro-beta-orcinic acid.—Beta-orcin, $C_8H_{10}O_2$, when treated with nitric and sulphuric acids as above described, gives a yellow substance, which appears to be the corresponding nitro-compound of beta-orcin; but, from the small amount of material at my disposal, I am at present unable to accurately determine its properties.

From some experiments I have made, the action of reducing agents, nitrous acid, &c., upon these nitro compounds promises very interesting results. I am at present investigating this subject. My thanks are due to Mr. Charles E. Groves for the efficient assistance he has rendered in conducting the above investigation.

ON THE CORONA SEEN IN TOTAL ECLIPSES OF THE SUN.

By Professor W A. NORTON.

Results of Observations on the Corona made at the Total Eclipse of August 7, 1869.

THE observations made on the corona on the occasion of the eclipse of 1869 have furnished several striking confirmations of the theory that it is an auroral phenomenon.

(1). *The Observed Form and Structure of the Corona.*—I will first adduce the results of my own observations. These were made at Des Moines, Iowa, with the naked eye and a good opera-glass, and were chiefly confined to the corona. When the totality commenced, and the beautiful corona stood revealed, like a new creation, against the dark background of the sky, almost the first striking feature that caught my attention was the great inequality in the extent of its outstreaming in different directions, and its consequent irregularity of outline. This outstreaming or luminous radiation was particularly conspicuous from the eastern limb, *nearly in the direction of the plane of the ecliptic or the sun's equator.* It could be distinctly traced in that direction to a distance from the sun equal to his own diameter. For an extent of some 15° on either side of the ecliptic, individual hair-like streamers, seemingly nearly parallel to the ecliptic, extended out a large fraction of this distance. From the opposite limb, and in the opposite direction, the coronal streamers were conspicuous, but of less extent than in the direction of the ecliptic toward the east. From the polar regions other pointed masses of light extended out to considerable distances, but not so far as those just noticed. They seemed to be composed, like the others, of rays or hair-like luminous radiations, more or less distinct. The separate luminous lines appeared to Professor Eastman, from the U.S. Naval Observatory (who observed the corona at the same station, through a small telescope) to converge more or less. This convergence I failed to detect; but I distinctly noticed that the outstreaming mass from near the north pole of the sun had approximately the form of a triangle with curved sides, convex outward, but the triangular outline appeared as if resulting from the intersections of individual radiations, rather than as being the definite boundary of a stationary luminous mass.

The corona had a white silvery lustre, and appeared at times suffused with a delicate rosy tinge, but this was probably a subjective effect. No flickering or variation of the lustre of the corona was observable during the totality; nor was there any noticeable change in its general form, or in the extent of its luminous radiations, though I carefully watched for such changes. Dr. B. A. Gould, who was stationed at Burlington, Iowa, and other observers, thought that both the lustre and extent of the radiating masses, or "star points," underwent material variations. A similar difference of opinion is found in the

reports of observations on previous eclipses. If variations in the brightness and extent of the coronal radiations do actually occur, it is favourable rather than opposed to the auroral theory of the corona; but it is probable that the apparent changes are due to inequalities in the interceptive action of the earth's atmosphere on the light of the corona, and especially on the faint light at its outer boundary.

Professor Harkness, of the U.S. Naval Observatory, in his able report of observations on the eclipse, states that the four angles of the trapezoidal outline of the corona were in the middle heliographic latitudes—relying upon the report of another observer; but on a direct examination of the question of the location of these angles, or "star points" of the corona, made since the publication of the report, he has satisfied himself that their actual position was such as I have above reported it from my own observations.*

In the delineations of the corona given by the observers of previous eclipses, two or more conspicuous outward extensions are generally shown, but the positions of these more projecting parts are seldom given with respect to the equator or poles of the sun. The figure of the eclipse accompanying the report of P. Professor Capellotti, of observations on the eclipse of April 15, 1865, made at Chili, is an exception. It shows three principal points of outstreaming of the corona; two lying very nearly in the plane of the sun's equator, and nearly diametrically opposite to each other, and a third near one of the poles of the sun. In the eclipses of 1858, 1860, and 1868, four such points were seen, distributed at about a quadrant's distance from each other. In the eclipse of 1842, but two were noticed, which were diametrically opposite to each other. In that of 1851, there appears to have been no marked deviation from a general uniformity of radiation.

Relying, then, upon the only definite knowledge we have of the location of the more conspicuous portions of the corona, viz., that obtained in the eclipses of 1865 and 1869, we may say that the corona is brighter and more extended about in the direction of the plane of the sun's equator than in any other direction. This striking fact lends a powerful support to the auroral theory of the corona; for, as we have already seen, the streamers proceeding from the lower latitudes on the sun, on opposite sides of the equator, should converge and intersect in the plane of the equator, and for a certain distance on either side of this plane, and, in consequence, the corona should appear to extend farther in the plane of the equator than in other directions. The convergence of individual rays or lines of emanation, we have already seen, was actually noticed by Professor Eastman. It, of course, may happen that inequalities in the amount of outstreaming on opposite sides of the equator may throw the more prominent and conspicuous parts of the corona to the one side or the other of the plane of the equator. It will be observed that, from our present point of view, the extension of the corona in the plane of the sun's equator is a phenomenon kindred to the much greater luminous extension seen in the zodiacal light; the only difference between them being, that in the former the auroral emanations proceed from lower heliographic latitudes, and intersect nearer the sun.

But it may be asked how are we to explain, on the present theory, the "star points" of the corona over the polar regions of the sun. For these, two reasons may be assigned. (1). If we admit a distribution of magnetism on the sun similar to that which prevails on the earth, the auroral streamers should diverge from each other less rapidly in the high than in the low latitudes. (2). Upon opposite sides of a line of no declination traversing the sun's surface, analogous to that which traverses Russia, the natural directions of the streamers prolonged upward would be such as to occasion the convergence and intersections of those proceeding from the opposite sides of this line.

We may say, then, that the more extended portions of the corona, in the eclipse of 1869, were over those regions of the sun's surface, and those only, whereupon the present theory the intersections of streamers might be expected to occur.

In some eclipses distinct luminous curves having the appearance of luminous jets issuing tangentially to the sun's limb, or obliquely inclined to it, and pursuing a course either convex or concave to the limb, have been seen. According to M. Liais, these peculiarities were conspicuously observable in the eclipse of September 7, 1858. While it is possible that such curves may be the result of the intersections of a mass of straight streamers, it is not improbable that they may be actual luminous jets; for if from any cause any portion of the auroral matter should be projected from the sun in a direction oblique to the surface, it would proceed in a convex hyperbolic curve if repelled by the sun, and in a concave curve if attracted. Now I have shown in a previous number of the *American Journal of Science and Arts* (July, 1861), that the portion of cometary matter posited on the convex side of the tail of Donati's comet was actually repelled by the sun, while that on the concave side had become detached from the head of the comet, because of a diminished gravitation toward the sun. Upon our fundamental conception that the coronal matter is essentially in the same physical condition as such cometic matter, and subject to the action of the same solar forces, it may well happen that some individual jets will proceed in convex and others in concave curves, according as the escaping matter is repelled or attracted by the sun.

(2). *Observations on the Physical Constitution of the Corona with the Spectroscope and Polariscope.*—The results of the observations made at the late eclipse, with the spectroscope and polariscope, are strongly confirmatory of the truth of the theory of the corona under discussion.

Professor Pickering, in the report of his observations with a polariscope, says, "The form of polariscope used was that adopted by Arago in his experiments on sky polarisation. It consists of a tube about twenty inches long and two inches in diameter, one end of which is closed by a double image prism of Iceland spar, and the other by a plate of quartz. Looking through the former, we see two images of the latter, which, when the light is polarised, assumes complementary tints. If, now, the corona was polarised in planes passing through the centre of the sun (as is generally admitted), when viewed through the polariscope, in one image the upper and lower parts should have appeared blue, and those on the right and left yellow; while in the second image these colours would be reversed, the yellow being above and below, and the blue on the sides. In reality, the two images were precisely alike, and both pure white, but one was on a blue and the other on a yellow back-ground. From this we infer that the corona was unpolarised, or at least, that the polarisation was too slight to be perceptible."

We may infer from this that the corona is either self-luminous or shines by diffuse reflection; since specular reflection produces polarisation.*

The testimony of the spectroscope is still more decisive. Professors Pickering, Harkness, and Young, agree that the spectrum from the light of the corona was a continuous one, or free from dark lines, but containing one or more bright lines. The absence of dark lines indicates that the corona did not shine by the light of the photosphere, reflected either diffusely or specularly from its substance; since such light, after reflection, should, like the direct solar light, have given a spectrum with the Fraunhofer lines. The presence of bright lines, on the other hand, is a direct indication that the corona was self-luminous; and therefore that its light was the result either of combustion

* Professor Winlock, in his report of observations on the eclipse, says, "the photograph of the corona taken at Shelbyville shows a flattening at the extremities of the sun's axis, and an elevation about the equatorial region." The photographic impressions obtained of the eclipse at the different stations show, however, but a small portion of the outward extent of the corona visible to the naked eye.

* The question whether the light from the corona is in any degree polarised or not cannot be regarded as definitively settled. It is to be hoped that the observations made on the eclipse of December will remove all doubt on this point.

or of electric discharges. As it is hardly supposable that an actual combustion could prevail at the distance of tens and hundreds of thousands of miles from the sun's photosphere, in regions where, if any solar atmosphere exist, the results of recent observations with the spectroscope by Lockyer and Frankland lead us to believe that it can only be the faintest possible trace of it, we must infer that the light of the corona is of electric origin.

In the hands of Prof. Young and Prof. Winlock, the spectroscope has obtained direct evidence of a physical correspondence between the solar corona and terrestrial auroras. Prof. Young observed in the spectrum of the corona a bright line, the position of which he gives as 1474 on Kirchhoff's scale, and which proves to be in coincidence with a small line marked as *iron* on Kirchhoff's and Angström's maps. He remarks that "it turns out also to coincide very closely, if it is not (which is much more probable) absolutely identical, with a line recently discovered by Prof. Winlock, of Cambridge, in the spectrum of the aurora borealis. He also saw two other fainter lines in the spectrum of the corona which coincided quite closely with other lines reported by Prof. Winlock as visible in the spectrum of the aurora. In view of these results of spectroscopic observation, he remarks as follows:—"At present it seems pretty likely that the spectra of the corona and the aurora borealis are identical, with only such differences in the intensity of their lines as we might naturally expect, and that very probably the identity extends to the essential nature of the phenomena themselves."

The detection of the same iron line in the aurora and corona, taken in connection with the well-established fact that the vapour of iron is present in the photosphere and chromosphere of the sun, and that the magnetic features of the aurora lead to the natural conclusion that some form of ferruginous matter constitutes the substance of auroras, for which no terrestrial origin can reasonably be assigned, conducts to the inference that the terrestrial auroral matter is derived fron the sun, and adds to the weight of accumulative evidence in support of the theory I have advocated that the corona is made up of material emanations from the sun.

NOTE.—Some persons have conjectured that the corona might be produced by the passage of the sun's rays through the earth's atmosphere, but it may readily be shown that this is impossible. When one reflects that the half width of the moon's shadow, in the larger eclipses, is as great as the estimated height of the atmosphere, it will be seen that, to an observer on the central line of the eclipse, the line of sight will not fall upon the illuminated portion of the atmosphere exterior to the shadow, unless inclined under a large angle to the line of direction of the centres of the sun and moon. The corona, therefore, if of terrestrial atmospheric origin ought to present, toward the middle of the eclipse, the appearance of a halo entirely detached from the dark body of the moon and many degrees distant from it. It ought also to increase in brightness from its inner border for a considerable distance outward.

Others have imagined that the corona might be attributable to the passage of the sun's light through a lunar atmosphere; but since some of the streamers, or rays of the corona, have been seen to extend to a distance greater than the sun's diameter, this would require the lunar atmosphere to be of vast extent; whereas no decisive evidence has yet been obtained of the existence of any lunar atmosphere capable of producing a sensible refraction, or reflecting a perceptible amount of the sun's light to an observer on the earth.

Perhaps the more prevalent idea, at the present day, is that the corona, with its rays and tufts of light, is a phenomenon of diffraction produced by the passage of the sun's rays along the denticulated edge of the moon. This theory has an air of plausibility, but it is entirely inadequate to account for the great extent of the coronal rays. The fringes produced by the diffraction of light in its passage near the edge of a body appear to the eye of the observer to extend but a small angular distance from the edge. This would be more strikingly true in the case of a distant body, like the moon.

The only remaining supposition is that the corona is either an envelope of some kind permanently connected with the sun, or is made of material emanations proceeding immediately from the sun, To the large body of indirect evidence that the corona is wholly a solar phenomenon that has been obtained, we may now add that of direct observation, since it apears that "an examination of the photographs of totality" obtained at the eclipse of 1869, shows that as the moon advanced the corona was progressively covered.—*American Journal of Science.*

ON BOILED OILS AND VARNISHES.*

By CHARLES W. VINCENT.

MY chief desire on the present occasion is to render as complete an account of the process of oil-boiling by steam as I can, without committing any breach of confidence towards those for whom I have been professionally engaged. A certain amount of reticence is necessitated by this latter consideration, but, at the outset, I may state that it applies only to the particular substances used to give the necessary drying or solidifying qualities to boiled linseed oil, and hence technically termed driers. The process itself may be used with any of the substances commonly employed in boiling oil by fire for the same purpose. The apparatus employed and *modus operandi* being well known throughout the trade, I am rather benefitting than injuring the cause of the manufacturers by publishing an account of the present state of a mode of manufacture which must, eventually, become the principal source of boiled oil.

The first consideration which presents itself to a practical man, on approaching a subject which he wishes to thoroughly master and understand, is, What do I want to do? the second being, How can I do it? Viewed in this way, it became evident to those engaged in this research that oil-boiling might be reduced to a much more simple and perfect operation than that ordinarily pursued.

The principal worker who has published the result of his researches is M. E. Chevreul, who, in 1856, in an admirable paper in the *Annales de Chimie*, definitely pointed out that the act of drying of linseed oil is one of absorption of oxygen, and consequently might more properly be termed solidification than drying (we will, however, retain the accustomed term); next, that many driers act catalytically; and lastly, that too long boiling retarded the drying of the oil. For instance, oil boiled three hours without driers, and afterwards three hours with litharge, dried more slowly than the same oil boiled for three hours with litharge, without any previous heating.

To whom the next discovery is due, viz., that the high temperature attained in oil-boiling by fire is unnecessary, I do not know. I discovered the fact for myself in 1859-60, when engaged in a research for Messrs. Leighton Brothers, of the *Illustrated London News*, on varnishes for printing inks; and at that time I introduced a mode of steam oil-boiling and varnish making which is still carried out by some of the largest makers of printing inks and those kinds of varnishes. The fact is now very generally accepted, though some manufacturers still hold aloof.

There are reasons which interfere with, and which stop the progress of, many arts and inventions, though against reason, and the oil trade is not free from these drawbacks.

* Read before the Society of Arts.

A principal one is, that the manufacturers are, in a great measure, tied down by the wishes and desires of their customers, so that, in many cases, they have to produce rather what the customers think they require than what they really need. It is this multiplicity of objects which causes the great variety of modes of manufacture of linseed oil for painting purposes. It is a common case to find that what one person, a large consumer, calls a thoroughly good boiled-oil, his neighbour, an equally large consumer, will pronounce entirely unfit for use. Now, it is my earnest wish that, as far as possible, you should hold yourselves free from preconceived notions of what constitutes a good boiled oil or varnish conventionally, and, considering merely the uses to which they are required to be put, reflect how far these requirements are met. My own personal experience has placed certain points before me as of paramount importance, and to these I shall direct your attention. Those characteristics which may be essential to the good quality of one mode of boiling oil, but do not forward results produced when these articles are applied to their various uses, I shall neglect.

Before entering upon my subject, I must remark that no paper read before the Society of Arts on oil-boiling and varnish-making can be complete and appropriate without at least some allusion to that communication on the subject presented by Mr. J. Wilson Neil, for which the Isis Gold Medal was awarded to him in the session 1832-3 of the Society, which was published in the *Transactions*, vol. xlix., part 2. It is not within the scope of the present paper to treat of the modes of manipulation, recipes, and precautions which he there so fully, carefully, and, indeed, conscientiously describes; but the fact remains that that paper was the foundation, and remains so to this day, of all the published accounts of modes of manufacturing varnishes. The alterations and modifications which have been from time time worked out are more in the shape of mechanical appliances for facilitating rapidity, easing labour, and providing greater safeguards against fire, than improvements of process. The principle of manufacture remains the same, and the varnishes now made cannot be said to be better in quality, though they may be made at a less cost, and in shorter time, than those produced under the processes detailed by Mr. Neil. Many firms still retain modes of operation almost (in some cases quite) identical with those he describes. The paper is still of such value that the Society would, even now, confer a benefit on the trade were they to republish it.

For a process of oil-boiling by fire, Mr. Neil's is nearly perfect; the new process depends on principles entirely different from those he dealt with, and therefore it is necessary to begin the subject, as it were, *de novo*. Linseed-oil is boiled for two reasons, as you all know—firstly, in order to facilitate its drying when spread on thin surfaces, either alone, or mixed with paint; secondly, that it may serve as a vehicle for the mechanical suspension of the finely-divided particles constituting a paint; that it may give a certain cohesive power to the mixed paint so constituted, enabling it to adhere to the surfaces on which it is spread, neither running into drops, nor leaving the colouring matters behind, but carrying the whole of the colour evenly diffused through it over the whole surface upon which the paint is laid, and when dry, forming together a surface which is, as far as may be, impermeable to gases and liquids. Technically, these are the two qualities which consumers rightly agree in desiring in boiled oil—that it should be a quick-drying oil, and have a good body. But it is frequently the case—and, in my opinion, they err in so doing—that consumers require in boiled oil, besides these two essential qualities, others in reality quite adventitious, to which, either from experience of some particular sample, from the custom of their trade, or from the mode in which they have been led to believe good boiled oil alone can be made, they attach a fictitious importance. It is of every-day occurrence that, unless the oil complies with these artificial demands, it is unhesitatingly condemned, independently of the two essentials upon which all are agreed. For instance, some persons attach the idea of a particular smell to be a good sample of boiled oil. If all were agreed as to what that smell should be, the desire would be easier to satisfy; but taking it for granted that the smell is a guarantee that the oil has been heated for a certain time at a certain temperature, it is obvious that two samples of oil may have that odour, whilst from the different ages of the oils previous to boiling, the quality of the seed from which they were expressed, or the driers employed, their qualities of drying and body may be widely different. Other persons, again, confine in their opinion good quality to a particular shade of colour and degree of brightness; a third party requires a particular shade of colour, body, and smell combined; others quarrel with their manufacturer if he vary his standard shade of colour, smell, &c. The truth is, that these are circumstances independent of the proper treatment of the oil. The varying qualities of oil require a varied treatment to bring them to one standard of body and drying power. If these be the standards to be maintained, the others, which, after all, are only indications that the oil had been manufactured, are of no importance. This applies to the ordinary process of boiling oil by fire, and I do not insist but that, if a uniform quality of oil be employed, and the same process always pursued, the colour and smell would be indications of the success of that particular process upon that particular oil; but, at the present day, the field from which you obtain linseed oil is much wider than it was of old; you cannot always buy the oil you prefer, and, of necessity, the mode of manufacture you adopt has to some extent to vary. If once the idea be thrown over that a high temperature is essential to the preparation of a good boiled oil, you at once obtain modifications of these peculiarities of colour and odour, though the other qualities, body, and drying power may be the same, or even increased.

With these preconceived notions it is that the new process of oil-boiling had, and still has to contend, people imagining that unless the boiled-oil attains a conventional standard of appearance, it of necessity must be bad. One of the advantages of the new process is hereby much diminished, since oil-boilers have to adopt expedients to give a colour to the oil which otherwise it would not have to nearly the same extent. And to the practical man an aim has to be added which frets and annoys common-sense and honesty of purpose, viz., that in addition to that of good and improved methods of manufacture, there must be sufficient similarity in appearance to accustomed samples to avoid awakening those prejudices against anything new, merely because it is new, still largely existing amongst the mechanical part of our population. It is the more to be deplored, since the colour of white zinc, delicate blues, &c., are much deteriorated by the dark oil used for mixing with them.

I discovered, in the beginning of 1860, that with suitable driers, I could obtain an oil which, although it had never been raised above the temperature of 228° F., nevertheless had the body and the drying power of a good boiled-oil. This led me to investigate the subject further, although the trade being limited, and the persons engaged in it having acquired a certain reputation for a good merchantable article, made by processes which they have not unfrequently worked out for themselves, they have not the same incentive to seek for improvements, or even to adopt them when brought before them, as exists in many other manufacturing processes. I do not claim any merit as an originator of steam oil-boiling, for I have reason to believe that it has been practised in Germany for many years past; but as far as I am personally concerned, I may state that all I know concerning the process I have discovered for myself, not even being aware that it was practised by others for some years subsequently to my own discovery and use of it.

Chevreul's experiments, to which I have previously alluded, form a good substratum for a disquisition on this

subject. The principle being clearly laid down that it is the absorption of oxygen by linseed oil which causes its solidification, it follows that all the substances which can be used as driers must be such as are capable of parting with oxygen or dissolving in it, and being themselves oxidisable in combination, they, in that way, increase its absorptive power. There is a class of driers which act whilst mechanically suspended in the oil, as white copperas, &c., for example, increasing its absorptive power by their presence, but leaving no increase of drying power when withdrawn.

The substances which act catalytically belong, in my opinion, to the first class. They part with some of their oxygen to this oil, become to a certain extent deoxidised, and again coming into contact with air they reassume their primal condition, and are ready to do the same work over again.

It is this necessity of re-oxidation which caused the introduction of blowing machines for oil-boiling, when their own proper advantages in rapidly giving body to linseed oil at comparatively low temperatures were at once, and to me unexpectedly, made manifest. These catalytic driers are now generally adopted, the effect of their use being simply this (and you will see that the result is a great advantage upon previous methods), that by treating the oil with these driers under the influence of heat and air, its own absorptive powers for oxygen are greatly increased, and remain so when the primary incentives to absorption are removed. This likewise has to be borne in mind, that what we want to do is not to render the oil solid or partially so now, but to enable it to become so when exposed to the air.

Many years ago, the late Professor Faraday was consulted as to the possibility of hastening the drying of printing inks so that work might be milled (that is compressed between zinc plates passed through closely-set rollers) with less delay after printing. A fortnight was the usual time taken, and, if ordinary driers were used, the whole of the ink would skin on the rollers, with many other inconveniences. Faraday's far-sighted sagacity at once decided that one solution of the difficulty would be by the mechanical introduction of a substance to act as a drier which should be inert till it was exposed to the air. As Professor Faraday's advice and assistance, in a research on the same subject for the same firm was of material service to me, and, indeed, enabled me to supersede the drier in question, I break no confidence by stating that it was binoxide of manganese which almost without experiment he at once pitched upon. By what process of thought he chose this substance I do not know, but the fact remains that he did so introduce it, and for, I think, between thirty and forty years it was used by the same firm. At the Queen's Bible-office they mill their work three days after printing, if it prove necessary. In order to get the binoxide in a state of division sufficiently fine to mix with printing-ink, he devised a series of washing receptacles, like successive stairs, the finer particles passing on to the lower vessels, being longer suspended than the coarser—a simple yet ingenious arrangement, which enabled the ink to be worked without any risk to the plates or formes from grit.

By properly pursuing this investigation, many other substances have been discovered which exercise this property in a high degree. Without becoming in any way altered, they induce an alteration in the linseed oil subjected to their operation. We may imagine the action as similar to that by which spongy platinum explodes a mixture of oxygen and hydrogen, or a platinum wire is kept red-hot by the vapour of ether.

Litharge and the other salts of lead perform the same office whilst in solution in the oil, and to their presence for the most part is the dark colour of boiled oil due. Where the steam process is used, the oil never reaches a sufficiently high temperature to produce carbonisation. By judiciously mixing one of the substances acting catalytically and a lead salt, a drier is obtained, by altering the relative proportions of which the boiler is enabled to produce any required shade of colour. The larger the quantity of litharge, the darker the colour of the boiled oil. A lesser proportion of litharge, accompanied by a greater quantity of the catalytic drier, gives as the product an oil which will dry in the same time, and has less colour. These are the principles of oil-boiling by steam.

(To be continued.)

NOTES OF

ANALYSES OF AN EARTHBALL AND INTESTINAL CALCULUS FROM THE HORSE.*

By JAMES F. STARK, F.C.S.

THE following serves merely to bring under your notice two analyses I had lately occasion to perform. The earthball was extracted, in the end of last year, from the large intestine of a horse belonging to Messrs. Charles Tennant and Co., of St. Rollox. In diameter it measures 5 inches, and weighs a little over 2 lbs. The section

shows that the materials of which it is composed have been deposited under various changes of circumstances—at one time growing solely by accretion of mineral matter, and at another time by mineral matter intermingled with substances of organic origin. In the analysis, a full section was taken, so as to ensure a fair average sample being obtained.

Magnesia	13·585	
Ammonia	8·828	
Phosphoric acid.. ..	24·109	83·197
Water (combined) ..	36·675	
Lime		0·239
Alumina		4·171
Ferric oxide		1·033
Soda		0·358
Phosphoric acid		0·189
Carbonic acid		0·015
Sulphuric acid		0·465
Silicic acid		5·202
Sodium chloride		0·490
Organic matter		4·686
		100·045

The remarkable feature in this analysis—indeed that on which its whole interest centres—is the very large proportion of ammonio-magnesic phosphate present.

Shortly after the performance of this analysis, I had the fact of the formation, to a large extent, of this ammonio-magnesic phosphate within the intestines of horses confirmed, by receiving several calculi that had been passed by a horse, and which the following analysis shows to have been formed almost entirely of this salt. The largest of these calculi measures nearly an inch in diameter. Analysis gave as follows:—

* Read before the Chemical Section of the Philosophical Society of Glasgow, March 27th, 1871.

Ammonio-magnesic phosphate—

$Mg_2P_2O_7$	44·504
$(NH_4)_2O$	10·424
$12H_2O$	43·301
	98·229
Organic matter—	
Soluble in HCl	0·801
Insoluble in HCl	0·910
	1·711
Silicic acid	0·044
	99·984

As to the condition of the blood necessary for the deposition of this ammonio-magnesic phosphate, I have not spent time in speculating—such comes more within the range of the physiologist. It is plainly enough seen, however, that, a small nucleus presenting itself (detained probably in some cavity), we have this salt thereon deposited. Now, if this goes no farther, no serious damage is done; such calculi seem to pass readily through the intestines, being smooth on the surface, and of a shape calculated to facilitate such a passage. It is only when the calculus assumes a nature similar to this large earthball that danger ensues to the animal—only when the ammonio-magnesic phosphate is intermingled with adventitious substances. How this intermingling of mineral and organic matter takes place I think I may be able to show. If we take a quantity of chopped hay, and sift the finer particles away from it, re-sifting these several times through finer sieves, and lastly through muslin, we arrive at a very finely-divided, dark-coloured mass. Again, on boiling a small quantity of this earthball reduced to powder, I find a certain amount of seemingly albuminous matter separate out, floating on the surface of the liquid. If we then suppose the surface of the calculus in part coated with this albuminous matter, any particles of this fine dust coming in contact with it would at once firmly adhere (indeed, examined under the microscope, this dust seems exactly fitted for such a work); over this, more ammonio-magnesic phosphate would be deposited, and so on, the mass gradually increasing in bulk. A substance similar to this dust is likewise found on grain, especially on oats, and is, I believe, sometimes separated, to the great improvement of the meal. In some districts, where this substance is not separated, the miller's horses are very subject to calculi. But here the horses do not suffer alone. Wollaston and Dr. Monro Tertius fully investigated, in their "Morbid Anatomy of the Human Gullet," a peculiar calculus endemic to Scotland, the frequent occurence of which amongst the population was assigned to the abundant use of oatmeal. Dr. Maclagan, in 1841, spoke of such as growing less common.

And now I have only one remark to make as to the practical application of this—one of no inconsiderable importance to the employers of horse-power in our large towns. What I have said points clearly to the necessity there is for thoroughly sifting all hay and grain used in the feeding of horses. Such, doubtless, in large establishments would entail a considerable expense, an expense, however, that in the long run would prove itself to be an economical one. I believe such a course has been pursued by Mr. John Clark, of Glasgow, in some establishments with which he has been connected, with very satisfactory results. When we see the large quantity of matter exactly resembling that met with in this earthball that can be extracted from a single stone of hay, and consider the number of stones consumed by a horse in the course of a year, we cannot fail to see that, by giving the animals the hay unsifted, no inconsiderable risk is run, but that we also condemn them to consume far more than the peck of matter incapable of assimilation, of which we are told we must all, at some time or other of our lives, become the unwilling possessors of.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

April 20th, 1871.

Professor Odling, F.R.S., Vice-President, in the Chair.

The following gentlemen were elected Fellows:—C. C. Grundy, S. B. Lee, G. Sutcliffe, W. Ward.

Mr. C. Haughton Gill read a paper "*On some Saline Compounds of Cane Sugar.*"

Péligot has described a compound of cane sugar and salt to which he ascribed a formula of $C_{24}H_{42}O_{21}NaCl$ (C = 6, H = 0·5, O = 8) which requires 14·92 per cent of sodic chloride: this indicates the replacement of 9 parts water by 58·5 parts of sodic chloride. Blondeau de Carrolles subsequently examined a similar compound, to which he ascribed the formula $C_{24}H_{20}O_{20},NaCl,3HO$, which includes water of crystallisation, of which Péligot makes no mention. Subsequently Mitscherlich denied the existence of the body, and Hochsteller mentioned that other chemists had failed to obtain it. Mr. Gill, being at first unsuccessful in preparing Péligot's compound by the method described, boiled a solution of sugar with an excess of salt for some time, filtered, and set aside the apparently uncrystallisable syrup. At the end of some months a few small, not very transparent, but individually distinct crystals had formed. They were drained, rinsed, pressed, and analysed. The numbers lead to the formula $2(C_{12}H_{22}O_{11})3NaCl.4H_2O$. This compound of an unexpected composition having been obtained, a number of solutions of sugar with various proportions of different salts were made up and set aside to crystallise spontaneously in a dry air space, or in the gentle and regular warmth of a sugar-house working-floor. Where crystals were not obtained by these means a more rapid evaporation was tried, or an alcoholic solution was slowly evaporated, and, in many cases, these and other methods were tried with liquids neutral, alkaline, and faintly acid. The salts employed were the chlorides of potassium, sodium, lithium, and ammonium, the bromides of potassium and sodium, and the iodides of potassium, sodium, lithium, and ammonium. In each case four solutions were prepared, having one, two, three, and four molecules of the salt to the double molecule of sugar, $2(C_{12}H_{22}O_{11})$. None of the potassium salts gave compounds of a definite composition. The mixture containing the chloride in the smallest proportion gave crystals of pure sugar,—those containing the two largest proportions gave a crop of the pure potassic chloride. From the solution containing 2KCl to $2C_{12}H_{22}O_{11}$, anhydrous crystals containing from 1·3 per cent to 19·6 per cent of potassic chloride slowly separated, leaving behind a mother liquid of the consistency of treacle.

The solutions containing potassic bromide behaved in a very similar manner, giving crystals often very clear and sharp, and sometimes 5 or 6 m.m. in extreme dimensions, but always anhydrous and of irregular composition.

Different specimens contained such proportions of potassic bromide as 24·8, 19·15, 16·17, 12·0, 7·56, 28·15, and 22·3 per cent. In appearance the crystals could not be distinguished from those of pure sugar. The solutions containing potassic iodide evaporated to very thick sticky masses, sometimes containing a number of minute crystals which could not be separated from the mother-liquor.

The sodium salts gave more definite results. In the case of the liquid, the solution containing least salt first gave crystals of pure sugar, and then, on further concentration, deposited crystals which are, doubtless, the same as those of the compound examined by Péligot, and are

identical with those obtained from the liquid containing the next higher proportion of salt, viz., NaCl to $C_{12}H_{22}O_{11}$. This compound crystallises in prisms terminated by pyramids; is very soluble in water, less so in spirit. From its solution in hot spirit of 85 per cent anhydrous crystals containing from 5 to 10 per cent of sodic chloride are deposited on cooling or slow evaporation. When to its solution in spirit of not more than 75 per cent ether is added, an oily layer is formed at the bottom of the vessel, and in this crystals form which have the composition $C_{12}H_{22}O_{11}.NaCl.2H_2O$.

The solutions containing sodic bromide can hardly be made to crystallise at all. A small quantity of minute confused crystals were deposited after some months from the solution containing $3NaBr$ to $C_{12}H_{22}O_{11}$; these, when pressed and dried over oil of vitriol, gave numbers which would point to a formula $NaBrC_{12}H_{22}O_{11}1\frac{1}{2}H_2O$, but it is more probable that when pure it is similar in composition to the analogous compound of sodic chloride.

The solutions containing sodic iodide give crystals of definite and constant composition with remarkable ease. These crystals always have the same composition whatever the proportions of the constituents in the mixture, unless one be in such large excess that it can in part crystallise out before the liquid becomes saturated with the compound.

The solutions containing a moderate excess of sodic iodide yield the best crystals and quickest growth. It can be re-crystallised as often as desired from water or dilute spirit without suffering decomposition, forming large transparent crystals even from small quantities of solution. Their constitution is expressed by the formula $2(C_{12}H_{22}O_{11}).3NaI.3H_2O$. None of the mixtures containing lithium gave any crystals other than those of sugar. Those containing a large proportion of the salt simply dried up to a gummy mass.

The mixtures containing ammonic salts gave no definite compounds. The chloride when in small quantity allowed sugar to crystallise out freely; when in large quantity it hindered crystallisation, but in time allowed the liquids to deposit well-formed, isolated, anhydrous crystals, generally opaque, but having the appearance of a definite body. These crystals, in fact, contained most variable proportions of ammonic chloride.

No results were obtained from the solutions containing ammonic iodide.

The crystals of sugar containing ammonic chloride and the equally distinct though generally smaller ones containing potassic bromide, and those deposited from a hot alcohol solution of the lower salt compound, must be built up by an anhydrous compound of the salt and sugar, isomorphous with sugar itself, crystallising out, together with an excess of the latter.

That the crystals are not simply sugar with adhering ammonic chloride is shown by their individual perfection and by the fact that they are deliquescent, whereas neither constituent is so.

The solutions of all the bodies described in this paper, especially that of the lower salt compound, exhibit persistent supersaturation in a remarkable degree. A saturated warm solution when cooled and shut up in an air-tight vessel with several crystals of the solid body, continues to deposit more of the compound for several months.

It is to be remarked that the sodium salts which give definite compounds are known to crystallise with two molecules of water when deposited at low temperatures, and that the iodide does so at all temperatures up to 20 per cent, whereas the corresponding potassium salts are anhydrous at whatever attainable temperature they may be crystallised. The composition of the sodic iodide compound makes it seem probable that the true molecular weight of cane sugar should be represented by $C_{24}H_{44}O_{22}$.

The measurements of the various crystals mentioned in Mr. Gill's paper were kindly executed by Professor W. H. Miller.

NOTICES OF BOOKS.

Second Annual Report of the State Board of Health of Massachusetts. Boston: Wright and Potter, State Printers. January, 1871.

IT is not unfrequently said in this country "they manage these things better abroad." Judging from the work before us this trite saying applies to the great Transatlantic Republic, originally founded by Republican Dutchmen, and years after endowed with a Constitution essentially the work of sound minded Frenchmen, of that "France intelligente, éclairée et libérale," to which fully applies the "Fluctuat nec Mergitur" of the Parisian coat of arms. The report of which the title is above given, is a very valuable contribution to what the Germans aptly term *Sanitäts Polizei*, of which, while the proper equivalent term of it in English is wanting, there is also rather too much wanting of the real tangible facts as put in force and expressed by that terse term. The following is the enumeration of the contents of this work:—General Report of the Board; Expenses of the Board in 1870 (these, we must not omit to state, are, as compared with the work effectually performed very moderate, but amount, moreover, to less than half the sum which the State Legislature of Massachusetts appropriated for the use of the Board in 1870); Report of the Secretary; Poisoning by Lead-Pipe used for the Conveyance of Drinking Water; Trichina disease in Massachusetts; Health of Towns; Charbon (Malignant Vesicle) in Massachusetts; The Causes of Typhoid Fever; Homes for the Poor; Convalescent Homes; The Sewage Question; Correspondence concerning the Effects of Intoxicating Drinks; Analysis of the Mortality of the City of Boston, in 1870; The Ventilation of School-houses; Mystic Pond, and its Sources of Supply; Air and its Impurities; Health of Minors Employed in Factories; Use of Milk from Cows affected with Foot and Mouth Disease. In about 440 pages there is condensed and concentrated a very large amount of valuable information, not bearing upon the State of Massachusetts alone, but also upon various other parts of the world, including Japan, Egypt, and a great number of other countries and localities. Since some portions of this work are specially interesting to chemists we propose to reproduce them at some future time. The volume is very creditably and carefully prepared, and also well printed, being an excellent specimen of an American "blue book," in the orthodox blue cover so well known in this country.

Ueber die Steinsalzablagerung bei Stassfurt und die Dortige Kali-Industrie, sowie über die Bedentungderselben für Gewerbe und Landwirthschaft. Von C. REINWARTH. Dresden: G. Schönfeld's Verlagsbuchhandlung (C. A. Werner). 1871.

On the Salt Deposit near Stassfurt, on the Potash Industry at that place, and on the Importance thereof for Manufacturing and Agricultural Interests. By C. REINWARTH.

IF any proof were required of the practical truth of the motto of one of the City Companies, "*Sal sapit omnia*," the small work before us (43 pages) bears evidence thereof in a very striking manner. The pamphlet contains, first, the detailed description of the discovery of the now renowned saline deposit met with near Stassfurt, now a place of importance as a large manufacturing town, formerly only a small market town, situated in a rural district at a distance of 20 kilometres S.W. from the well-known city of Magdeburg. The description refers to the geognostic features of the country round about Stassfurt, details the results of a series of borings made for the purpose of ascertaining the nature of the minerals found under the surface of the ground, and includes the exhaustive description of

the various saline minerals found among the layers of rock-salt. This is found not only very abundantly, but also of great purity; while interspersed with it are found substances not hitherto found anywhere else (excepting quite recently near Kaluscz, in Galicia, near the Lemberg-Czernowitz Railway, where a saline deposit has been discovered which is both extensive and very rich in potash salts). Among the salts spoken of by the author, we briefly mention the following:—Carnallite, so named in honour of Herr Carnall, a Prussian mining engineer, a double chloride of potassium and magnesium, mixed, however, with other salts; stassfurtite, a peculiar mineral which contains boracic acid; sylvine, a more or less pure chloride of potassium; kainite, a compound containing sulphuric acid, potash, magnesia, chlorine, and water.

In addition to common salt refining, the great industry of Stassfurt is the manufacture of chloride of potassium. The author of this excellent pamphlet gives a minute and lengthy description of the various processes which are employed for separating the various salts from each other, and the utilisation of the by-products thus obtained. We learn from the pamphlet before us that, as far, at least, as geology can give a clue to this matter, the saline deposit found, and successfully wrought, near Stassfurt may extend for several miles farther than the locality alluded to. In order to give some idea of the enormous quantities of saline materials produced, suffice it to say that the weights, obtained in 1869, of the potash salts amounted to 109,075 tons, and of rock-salt to 56,332 tons.

CORRESPONDENCE.

HIGH AND LOW CHEMISTRY.

To the Editor of the Chemical News.

SIR,—As a member of the commitee of the Lincolnshire Farmer's Association, will you allow me to make an appeal to your professional readers to throw a little scientific light on a matter which to us "bumpkins" is very perplexing.

We contract yearly for several thousand tons of phosphatic manure, with the condition that it shall contain 26 per cent of soluble phosphate, or phosphate made soluble! and subject to the analysis of some qualified chemist. Now, we find that, as a rule, A—* is invariably selected by the maker, and B—* by the consumer; indeed, this question involves a difference of many shillings per ton, whether what they term the high or low analyst is appointed. I was not aware, until I came in contact with these chemical perplexities, that science, like theology, had the comical characteristics of high and low. To satisfy you that such differences do exist, I beg you will read the report and correspondence which I send with this letter. The report or analysis was made upon samples of manure sent to A—and B—, taken from the same bulk, and with the greatest possible care. The difference you will observe is 3·6 per cent—equal to eleven shillings per ton, or 14 per cent in the original cost—and this is not a solitary case, for it is notorious in the trade that such differences between these chemists do exist, and that in contracts involving amounts of many thousands of pounds, the question of which of these two chemists shall be accepted as analyst is one of great pecuniary consideration, and is an important condition in the terms of contract.

When we ask for some explanation, you will observe the reply is either nothing, or that there is some difference in the process of analysis! but, I am informed, that to ascertain the amount of soluble phosphate *only*, the process is neither uncertain, difficult, nor complex; therefore, taking the average of a number of cases of analysis, the difference between any two or more competent chemists should not exceed a half per cent, and certainly not such as to constitute the notorious reputations of high and low analysts. It may be that temperament is concerned, and that the high analyst may be so generously inclined as to adopt the Jack-o'-both-sides policy, and, by giving high reports, hope to please buyer and seller; whilst the low analyst, being constituted of more severe and sterner stuff, may care only for his fee, and for neither party.

The claims on chemistry by agriculture are now so extensive and important that I hope these differences between two eminent chemical analysts may be clearly explained, and may not be, as they at present appear, a chemical scandal.—I am, &c.,

W. LITTLE.

The Hall, Heckington,
Lincolnshire.

PS. Since writing the above I observe that a manure maker and a chemist have addressed you on this same subject, as representing a large body of consumers. I hope you will find space for our "growl." Our association now distributes more than four thousand tons of phosphate manure yearly amongst its members, and, in a short time, our demand will be ten thousand tons; consequently, a difference of eleven shillings per ton is a matter of some moment.

* For the present we think it will be better not to publish the well-known names here represented by A. and B.—*Ed. C.N.*

ELECTRO-MAGNETIC THEORIES.

To the Editor of the Chemical News.

SIR,—It is almost needless for me to say that Mr. Highton has altogether misunderstood my meaning when he says "Dr Joule has withdrawn the details of his theory, and substituted others." My object, in the paper to which he refers, was to place the theory in a light which would make it more intelligible to those who have not worked on the subject.—I am, &c.,

JAMES P. JOULE.

[As a continued discussion on this subject cannot interest the majority of our readers, we can devote no more space to it.—*Ed. C.N.*]

MISCELLANEOUS.

Royal Polytechnic Institution.—A lecture on "Snow, Ice, and Glaciers," by Mr. Pepper, forms, just now, the staple attraction at this institution. The discourse is one of considerable interest, and is delivered with much tact by the lecturer, who knows well how far he dare trespass upon the patience of his audience without touching the limits of boredom. Some fine photographs of glacier scenery in Switzerland, Tyrol, and the Pyrenees, thrown upon the big screen help to convince the audience of the soundness of the theory of glacier motion which Mr. Pepper brings forward. As usual, there are several other entertainments of a lighter character provided for visitors, and of these, one by Mr. George Grossmith, jun. deserves special mention. This gentleman cleverly hold up to ridicule some of the well-known portrait types to be seen in every photographic album, and moves the audience to laughter by representing to them their own follies. Mr. Grossmith's little entertainment is indeed full of fun and genuine humour.

Improved Automatic Spectroscope.—At the recent *soirée* of the Royal Society, Mr. J. Browning exhibited a spectroscope, in which the rays of light pass through two batteries of prisms, and was then sent back through both trains of prisms by means of a reflecting prism placed behind the last prisms of the train, to the eye of the observer. In this manner a dispersive power equal to nineteen prisms of flint-glass is obtained. Both

trains of prisms, as well as the intermediate prism, are under the control of an automatic movement, which ensures that every ray shall pass at the minimum angle of deviation, for the particular ray under examination. Both the collimator and telescope are fixed; the prisms only are movable—it will readily be understood that this arrangement is highly advantageous. Mr. Proctor suggested this extension of Mr. Browning's automatic spectroscope, and contrived the form of prisms which would enable the automatic action to be carried on, but the mechanical difficulties, in communicating the automatic motion to the second battery were very considerable. These difficulties Mr. Browning has ingeniously surmounted. The D lines in the spectrum of sodium are seen in this instrument, separated by an apparent interval of more than ¼ of an inch, and, under favourable conditions of the atmosphere, ten or twelve lines are visible between them. We understand that Mr. Spottiswoode, the Treasurer of the Royal Society, has become the possessor of this instrument.

Quality of the London Gas.—Dr. Letheby, the Chief Gas Examiner appointed by the Board of Trade, has recently reported to the Corporation of the City, and to the Metropolitan Board of Works, on the quality of the gas supplied to the metropolis during the last three months by the Chartered, the Imperial, and the South Metropolitan Gas Companies. He states that the range of illuminating power has been somewhat large in several instances, as in the case of the Chartered Gas, at Gray's Inn Road, and of the Imperial Gas, at Graham Street and Oakley Square, as well as the South Metropolitan Gas, at Hill Street, where the fluctuations have been to the extent of about three candles. The average illuminating power of the common gas supplied to nine testing stations during the quarter, has been as follows:—Firstly, with respect to the Chartered Gas, it was equal to 16·87 standard sperm candles, at Gray's Inn Road; 17·21 candles at Arundel Street; 17·41 at Leadenhall Street; 17·67 at Cannon Street; and 17·93 at Friendly Place, Mile End. Secondly, as regards the Imperial Company's gas, it was equal to 15·68 candles at Camden Street; 16·46 at Graham Street; and 16·49 at Oakley Square. Thirdly, with respect to the South Metropolitan gas, it was equal to 16·15 candles. On two occasions, the common gas of the Chartered Company, at Gray's Inn Road, was a little below the requirements of the Act of Parliament. The average illuminating power of the Cannel gas supplied by the Chartered Company was 23·15 candles at the Cannon Street testing-place, and 25 candles at Arundel Street. As to the purity of the gas, it was reported of as being at all times free from sulphuretted hydrogen, but as containing very variable proportions of sulphur, as from an average of 11·5 grains per 100 cubic feet of the Cannel gas of the City works, to 36·11 grains per 100 feet of the common gas at Gray's Inn Road; and between these extremes, there were the following average proportions of sulphur per 100 cubic feet, namely, 19·69 grains in the common gas from the Great Central works; 25·98 in that from the City works; 26·81 in the Cannel gas at Arundel Street; 27·22 and 28·11 in the Imperial Gas at Graham Street and at Camden Street; 31·35 in the Chartered common gas at Arundel Street; 33·02 in the South Metropolitan gas; 35·21 in the Imperial at Oakley Square; and 35·18 and 36·11 in the Chartered gas at Leadenhall Street and Gray's Inn Road; the range, therefore, in the average amount of sulphur in the Cannel gas supplied by the Chartered Company has been from 11·5 grains at Cannon Street to 26·81 grains at Arundel Street; and in the common gas of the several companies it has ranged from 19·69 grains at Friendly Place to 36·11 at Gray's Inn Road. Dr. Letheby draws attention to these large differences in the amount of sulphur at the different works, and says that the public have a right to the advantages offered by the best system of purification, for in the case of Cannel gas, it must evidently be more perfect at the City works, where the average amount of sulphur is only 11·5 grains per 100 feet of gas, than at the other works, where it is 26·81 grains; and in that of common gas, it likewise must be better at the Great Central works, where it averages 19·69 grains, than at the works which supply the Gray's Inn Road testing-place, where it has averaged 36·11 grains per 100 feet. The quantity of ammonia in the gas supplied from several stations has never exceeded the amount prescribed by the referees, namely, five grains per 100 cubic feet of gas.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de l'Académie Impériale des Sciences de St. Petersbourg, vol. xv., No. 3, 1870.

This number contains the following original papers relating to chemistry and collateral sciences:—

Physical Properties and Calorific Power of some of the Petroleums found in the Russian Empire.—H. Sainte-Claire Deville.—This essay treats on the petroleum oils found near to the Caspian Sea, the author having been commissioned by the Russian Government to investigate and report upon the use that can be made of these oils as fuel for steamers plying on the sea just mentioned. The essay is divided into the following sections:—Estimation of the degree of volatility; specific gravity and co-efficient of expansion by heat; elementary composition varied for different samples (but the quantity of oxygen contained in the oils operated upon did not in any case exceed 1·5 per cent, the lowest quantity of that element found in the samples being 0·1 per cent); calorific power, or heat given off by combustion.

The Olivine of the Pallas Iron (Pallas Eisen).—N. von Kokscharow.—A mathematico-crystallographical essay, illustrated with engravings.

Studies on Ozone, Peroxide of Hydrogen, and Nitrite of Ammonia.—H. Struve.—This essay, though marked as a preliminary notice, treats on the presence of ozone, peroxide of hydrogen, and nitrite of ammonia in atmosperic water (rain, snow, hail, clouds), and on the part these substances play in the processes of respiration and digestion (nitrite of ammonia is a constant constituent of saliva and the liquids of the stomach) of men and animals.

Derivatives of Desoxybenzoine.—Dr. Zinin.—This lengthy monograph does not admit of any useful abstraction, notwithstanding the intrinsic merits of the essay, which, to be well understood, would require the reproduction of a large number of formulæ.

Note on the Bodies Corresponding to the Nitrated Products of the Benzoil-Anilide.—Dr. Lazorenco.—A brief paper chiefly containing a series of formulæ.

Jahrbuch der Kaiserlich-Königlichen (Austro-Hungarian) Geologischen Reichsanstalt, No. 4, 1870.

This number does not contain any papers directly relating to chemistry or collateral sciences, but is full of very valuable matter bearing upon the geology, mineralogy, and geognosy of the extensive Austro-Hungarian Empire and some adjacent countries, including Servia and Turkey.

Bayerisches Industrie und Gewerbe Blatt, January, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and collateral sciences:—

Review of the Objects most Noteworthy, in an Industrial and Technical respect, Exhibited at the Exposition held at Cassel.—Dr. E. Wiederhold.—Illustrated with engravings.

The Pigments and Dyes derived from Naphthaline and Phenic Acid.—Dr. L. Janke.—This very lengthy and exhaustive memoir is divided into the following sections:—Naphthaline, preparation and properties; nitro-naphthaline; binitro-naphthaline; naphthylamine (naphtholidine); biamido-naphthaline; pigments obtained from naphthylamine; phenic acid; picric acid; isopurpuric acid; phenyl brown.

Suggestions concerning a Rational Mode of Utilisation of the By-Products obtained by the Manufacture of Gas from Coals.—Dr. A. Wagner.—This essay treats on the best means of utilising coke and breese, gas tar, ammoniacal liquor, and naphthaline.

Revue Universelle des Mines, de la Métallurgie, des Travaux Publics des Sciences et des Arts Appliqués à l'Industrie (double number), November and December, 1870.

This number contains, in addition to a large number of excellent papers relating to mechanical science, engineering, and railway matters, an essay on the—

Estimation of Sulphur in Cast-Iron, Review of the Methods hitherto Employed, and Description of Two New Processes suited for this purpose.—Dr. L. de Koninck, C.E.—This essay is, in its first portion, a review of the various methods applied, and generally known, for the estimation of sulphur in cast-iron; next, we meet with the detailed description, illustrated by engravings, of two new methods tried by the author and M. Dietz. The principle of the first of these methods is based upon the formation of sulphuretted hydrogen from cast-iron, when treated with dilute hydrochloric acid, and the passing of that gas into a neutral solution of nitrate of silver, and the formation of sulphide of silver, which, being separated by filtration, is treated with bromine in the presence of water, when the following reaction takes place:—

$$Ag_2S+8Br+4H_2O=2AgBr+6HBr+H_2SO_4.$$

Since bromide of silver is insoluble, the estimation of the sulphuric acid, after separation of the insoluble bromide, presents no difficulty. The reader should understand that the authors have devised a properly-arranged apparatus for the execution of this process. The other process is based also upon the evolution of sulphuretted hydrogen from the iron, and the passing of the gas into a neutral solution of sulphate or chloride of cadmium; the result is the formation of sulphide of cadmium, and the setting free of a quantity of acid equivalent to the quantity of the salt converted into sulphide, which free acid is, after the separation of the sulphide by filtration, estimated by means of a titrated solution of ammonia or of caustic potassa.

Zeitschrift für Chemie von Beilstein, No. 2, 1871.

This number only contains the two following original papers:—

Products of the Oxidation of Durol: Cumidic Acid.—P. Jannasch.—Cumidic acid, $C_{10}H_{10}O_4$, is a bibasic acid, homologous with terephthalic, phthalic, isophthalic, uvitic, and xylidic acids. Cumidic acid is insoluble in cold and boiling water, hardly at all soluble in ether and benzol, rather more soluble in boiling alcohol. At a very high temperature, this body sublimes without fusing, previously forming well-defined crystals. Cumidate of lime, $Ca.C_{10}H_8O_4+2H_2O$, forms prismatic crystals, is not acted upon by exposure to air, can be heated to 200° without undergoing decomposition, and is readily soluble in water. Cumidate of baryta, $Ba.C_{10}H_8O_4+2H_2O$, crystallises in rhombs. The author, who is engaged in further experiments on this subject, states that he has found a method of obtaining durol (a hydrocarbon, C_9H_{12}) by the direct methylisation of coal-tar pseudo-cumol.

Some Derivatives of Propionic Acid.—F. Sestini.—The author describes, at length, the mode of preparation of the following substances:—Propionylamide, C_3H_5O,H_2N, a colourless body, readily soluble in alcohol, ether, and chloroform; crystalline; fusing between 75° and 76°; sublimable at a higher temperature. Hydrochlorate (*salzsaures*) of propionylamide, $(C_3H_5ONH_2)2HCl$, a deliquescent substance, readily soluble in alcohol, but not in ether; exhibits acid reaction to test-paper; forms prismatic-shaped crystals. Mercuro-propionylamide, $(C_3H_5O)2HgH_2N_2$. Propionyl-anilide (phenyl propionylamide), $C_3H_5O.C_6H_5.HN$. Neutral propionate of ammonia, $C_3H_5O.ONH_4$. Propionic ether is most readily prepared by distilling together a mixture of 24 parts of alcohol at 95 per cent, 18 parts of propionic acid, and 4 parts of sulphuric acid.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, February, 1871.

This number does not contain any original papers or memoirs relating to chemistry and allied sciences.

Journal für Praktische Chemie, No. 3, 1871.

Behaviour of Normal Iodide of Butyl towards Alcoholic Potassa Solution.—A. Saytzeff.—Continuation and end of this lengthy essay, which, notwithstanding its intrinsic merits, is not well suited for useful abstraction.

Constitution of Diglycolic Acid and Triglycolamidic Acid.—W. Heintz.—This paper, and the next, by A. Claus, are critical reviews of the labours of Professor Kolbe, as published on this subject.

Essay on Structural Formulæ, and on the Doctrine of the Connection (Binding) of Atoms.—Dr. H. Kolbe.—Illustrated by diagrams.

Alleged Unfitness of Potassa for the Formation of Ultramarine.—W. Stein.—This paper records a series of experiments made by the author with the view to elucidate the fact already observed and recorded by the late Professor Gmelin, and afterwards confirmed by Dr. Ritter, that if, instead of soda, potassa be used for the preparation of ultramarine, that pigment is not formed, the conditions of the operation remaining in all respects the same. The results of the author's experiments confirm the original statements, and the explanation of the phenomenon is found in the hygroscopicity of the potasso-alumina silicate, and its consequent more easy decomposition and incapability of preventing the decomposition of the sulphuret of aluminium it envelops.

Volumetric Estimation of Peroxide of Iron by means of Iodide of Potassium.—Dr. A, Schwarzer.

New Phenyl-Diamine.—P. Griess.—The first page of a mono graph on a new phenyl-diamine, different from—

	Point of fusion.	Boiling-point.
α phenyl-diamine (Hofmann) ..	63°	287°
β phenyl-diamine (Hofmann) ..	140°	267°
New phenyl-diamine	99°	252°

The American Journal of Science and Arts, April, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Some Forms of the Galvanic Battery.—S. P. Sharples.—The account of a series of experiments made with various forms of galvanic batteries and with various exciting liquids. As regards the latter, the author states that the sulphuric acid (1·84 sp. gr.) should be mixed with nine times its volume of water, and allowed to stand until the precipitated lead has settled. The absorbing fluid best suited is stated to be ordinary commercial nitric acid saturated with potassic bichromate, best at a moderately warm temperature. To this solution is added one-third of its bulk of sulphuric acid, and enough water to re-dissolve the chromic acid precipitated; this mixture is less expensive than pure nitric acid alone, and the internal resistance is decreased.

Method of Fixing, Photographing, and Exhibiting the Magnetic Spectra.—Dr. A. M. Mayer.—Reserved for full reproduction, an observation also applicable to the following valuable paper:—

Determination of the Alkalies in Silicates by Ignition with Carbonate of Lime and Sal-Ammoniac.—J. Lawrence Smith.

This number abounds in valuable and interesting papers bearing upon geology and astronomy.

NOTES AND QUERIES.

Sugar Refining.—(Reply to J. T. A.)—Dr. Seyferth's process alluded to by you, not for *sulphuric*, but for *sulphurous acid*, is described in Chemical News, vol, xxii., p. 248.

Densimetre.—Would any of your readers inform me how, and on what principle, the "densimetre" is worked? It is, I believe, an apparatus used to determine the density of gunpowder.—Charcoal.

Mixed Fabrics.—In Chemical News, vol. xxii., p. 169, you published a paper "On the Discrimination of Fibres in Mixed Fabrics." Would the author, Mr. Spiller, please say what strength (Twaddell) the hydrochloric acid should be?—X.

Valuation of Orchil.—Will any of your readers kindly inform me of a ready method among analysts for the quick valuation of *Orchella* weeds? A process exists of dyeing a piece of flannel with the extract, the flannel being subsequently submitted to comparison with other pieces similarly dyed with other samples, but I have not been able to arrive at this end within less time than ten days, whereas I believe it is to be done in a much shorter space of time.—Orchil.

Improved Bunsen Battery.—At the last meeting of the British Association for the Advancement of Science, Professor Williamson brought forward, very prominently, a notice and partial description of a new galvanic battery, invented by Professor Bunsen. He (Professor Williamson) stated that he could not, as yet, give the form, dimensions, exact composition of the exciting liquid, &c., Professor Bunsen, owing to the war, not having at that time forwarded them. He further stated, however, that, *ceteris paribus*, the electromotive force of the new battery, compared to a Grove's, was as 23 to 18; that it required no porous cells or partitions, and had only one (compound) exciting liquid. I have looked through the Chemical News, &c., for it ever since, but have failed to see any account of it. If it is published, I am desirous of ascertaining where. It seems to me to be a matter of great importance if electricity is ever to be of use as a motive power, also for medical and various other purposes.—James M. McCulloch.

MEETINGS FOR THE WEEK.

Monday, May 1st.—Medical, 8.
—— London Institution, 4.
—— Royal Institution, 2. Annual Meeting.
Tuesday, 2nd.—Zoological, 9.
—— Civil Engineers, 8.
—— Royal Institution, 3. William Pengelly, Esq., F.R.S., F.G.S., "On the Geology of Devonshire, especially of the New Red Sandstone System."
Wednesday, 3rd.—Society of Arts, 8.
—— Microscopical, 8.
Thursday, 4th.—Chemical, 8. Dr. Voelcker, F.R.S., "On the Productive Powers of Soils in Relation to the Loss of Plant Food by Drainage."
—— Royal Society Club, 6.
—— Royal, 8.30.
—— Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
Friday, 5th.—Royal Institution, 9. W. R. S. Ralston, M.A., "On Russian Folk-Lore."
—— Geologists' Association, 8.
Saturday, 6th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."

THE CHEMICAL NEWS.

VOL. XXIII. No. 597.

ON THE ESTIMATION OF PHOSPHORIC ACID IN SUPERPHOSPHATES.

By ROBERT WARINGTON, F.C.S.

THE fact to which Mr. Purser has called attention in a recent number of the CHEMICAL NEWS (vol. xxiii., p. 178), is one only too well known to those concerned in the manure trade. There are, unfortunately, considerable discrepancies in the reports of analysts of superphosphates; a little ventilation of the subject cannot but prove wholesome.

In the first place, are analysts agreed as to what they understand by soluble phosphate; do they understand phosphates soluble in hot or in cold water?

Exhaustion of the superphosphate with hot water may give, according to circumstances, more or less soluble phosphate than exhaustion with cold water. If the superphosphate contain soluble compounds of alumina, it will yield less soluble phosphate when boiled with water than if the exhaustion is conducted in the cold, and the difference between these two modes of operating may be very considerable. A simple experiment will satisfy any one on this point. If a cold solution of superphosphate be treated with alum, or other soluble compound of aluminium, the solution appears unchanged. On applying heat turbidity commences, and when the boiling-point is nearly reached a copious precipitation of phosphate of aluminium takes place; on cooling, the precipitate, if not too considerable, entirely re-dissolves. This reaction is certainly remarkable, and the cause not very apparent: one is tempted to think that the aluminium is, in the case assumed, combined in the cold with sulphuric acid, and in the hot with phosphoric, and that a change of temperature effects a change in the degree of affinity of aluminium for these two acids. The practical result is, however, very plain; superphosphates containing aluminium in a soluble form will yield less soluble phosphate to hot water than to cold.

Most superphosphates yield solutions in the cold which contain traces of alumina; when, however, the superphosphate has been made from Navassa phosphate, or other of the native phosphates rich in alumina, the amount of aluminium salt soluble in the cold may be very considerable; the quantity depends, however, in great measure, on the manner in which the superphosphate has been manufactured. The presence of aluminium in the solution is, of course, at once indicated by the formation of a precipitate on boiling.

Before leaving this part of the subject, I may just mention, that the reaction of ferric salts with solution of superphosphate is wholly different from that described above. Soluble ferric salts produce an immediate precipitate in the cold, and are, consequently, never found, save as traces, in a solution of superphosphate.

From the above considerations, it seems evident that the removal of the soluble phosphate should always be effected with cold water. The maximum amount of phosphoric acid appears to be dissolved when, after thorough exhaustion with cold water, the residue is lastly boiled. In this case, the hot water probably effects a partial decomposition of the reduced phosphates. The increased amount of phosphate rendered soluble by the hot water is by no means considerable, and can hardly be fairly reckoned as soluble phosphate, which, in its character of a manure to field crops, must surely be understood as a phosphate soluble in rain water.

The best mode of extracting the soluble phosphate is, I believe, the following:*—10 grammes of the carefully mixed sample are placed in a mortar. A flask, marked to deliver 1 litre of water, is filled, and fitted as a wash-bottle. The superphosphate is moistened with some of the water, and rubbed smooth with the pestle; more water is added, the whole well stirred, and the solution and fine particles decanted into a bottle. The residual superphosphate is brought to a finer state of division by means of the pestle, and is again treated with water as before; and this rubbing and washing are repeated until the whole of the manure has been transferred to the bottle in a fine state of division. The rest of the water is next added, and the bottle shaken at frequent intervals during three hours. 100 c.c. of the solution correspond to 1 grm. of the superphosphate.

The estimation of the phosphoric acid in the watery solution may, of course, be effected by any of the trustworthy methods with which chemists are acquainted. The most usual plan is to precipitate the phosphoric acid as tricalcic phosphate by means of ammonia, with or without the addition of chloride of calcium, according to the proportion of lime present in the solution. The other methods which seem specially applicable, are precipitation by magnesia, and by uranium.

Precipitation by acetate of uranium cannot be used when alumina is present in any notable quantity, unless the phosphate of aluminium is first removed by acetate of ammonium and separately determined. The uranium method when used gravimetrically, is a very good one: employed volumetrically, it is admitted to be somewhat less accurate.

The magnesia method is available under all circumstances, and is worthy of great confidence. The superphosphate solution is to be treated with excess of oxalate of ammonium; the acid phosphates present liberate enough oxalic acid to keep the phosphates of aluminium and iron in solution. The oxalate of calcium is removed by filtration, and the filtrate treated with citric acid, excess of ammonia, and magnesia mixture.

The usual plan of estimation as tricalcic phosphate, is of quite sufficient accuracy for commercial purposes when properly conducted, but lies open to several distinct sources of error. Thus the "high analyst," by precipitating with a considerable excess of ammonia from a solution containing excess of lime, obtains a phosphate containing notably more calcium than tricalcic phosphate, and his result is, consequently, above the truth. This error is met by some by re-dissolving the phosphate containing excess of lime, and re-precipitating it; the error may, however, be avoided in the first instance, by limiting the amount of ammonia employed. If ammonia is only used in just sufficient quantity to distinctly turn turmeric red, tricalcic phosphate may be successfully precipitated from cold dilute solutions containing much lime in excess. An error of a different kind arises from the difficulty of washing all the sulphates out of the gelatinous phosphate, and from the fact that the washing must not be pressed too far, as loss of phosphate occurs in the later stages of washing. I would strongly advise those commercial analysts who may be in the habit of always estimating soluble phosphate by precipitation with ammonia, to test their result a few times by duplicate analyses executed by the magnesia method, and thus ascertain whether the conditions they habitually employ are consistent with accuracy.

The following results, obtained with two superphosphates, show the amount of agreement that may be expected from the different methods described:—

	Estimation as tricalcic phosphate.		Estimation as phosphate of magnesium.	Estimation as phosphate of uranium.
(1).	24·65	24·55	24·19	24·90
(2).	17·3		16·82	16·50

The determinations of insoluble phosphate in superphosphate are, I fear, more generally inaccurate than

* This method, is I believe, of German origin; I became acquainted with it at Mr. Lawes' laboratory at Harpenden.

those of soluble phosphate; they are usually greatly in excess of the truth. The manufacturer can tell very nearly the total amount of phosphate present in his manure. Thus, if he makes superphosphate with equal weights of Cambridge coprolite and sulphuric acid, he knows that, allowing for the loss in mixing, the product will contain almost exactly 32 per cent of phosphate reckoned as tricalcic; and any nitrogenous matter he may have added to his materials will only diminish the percentage of phosphate. What, then, is his surprise, on receiving the report of the scientific chemist, to find that the soluble and insoluble phosphate added together give a total of over 40 per cent; a result not very uncommon. If commercial analysts would remember that only high-priced superphosphates, made entirely from Sombrerite or bone-ash, can possibly contain 40 per cent of phosphate, they would save themselves from many mistakes.

The origin of this error is that less care is taken in determining insoluble phosphate than in the estimation of soluble: that the portion of the superphosphate undissolved by water is dissolved in acid, and the solution precipitated with a large excess of ammonia, without any attention to the nature of the substances precipitated.

It is best to determine the *total* phosphate present in the superphosphate by one operation, and then, by deducting the soluble phosphate, to find the insoluble. If the superphosphate has not been made from ferruginous or aluminous materials, the solution of the superphosphate in hydrochloric acid, and the precipitation of the phosphates by the limited amount of ammonia already referred to, will give sufficiently accurate results. In all other cases, the hydrochloric solution of the superphosphate should be neutralised as far as possible without causing a precipitate, and then treated with excess of oxalate of ammonium, and subsequently with citric acid and magnesia mixture as already described.

In conclusion, it must not be forgotten that the faulty processes in use by commercial analysts are to no small extent due to the pressure put on them by the public. When the fee given is reduced to the lowest possible point, the analyst is forced to regard the number of his analyses as of more importance than their quality, and to adopt methods, the main object of which is to enable him to snatch a result in the shortest possible time.

ON THE EXISTENCE AND FORMATION OF SALTS OF NITROUS OXIDE.*

By EDWARD DIVERS, M.D.

Metallic sodium thrown on a solution of an alkali-nitrate was found by Schönbein to reduce it to nitrite. He contented himself, however, with merely detecting the nitrite by the iodide and starch test. By using the sodium in the form of amalgam the complete reduction of the nitrate to nitrite can be readily effected, and silver nitrite freely precipitated from the solution, by first neutralising it with an acid, and then adding silver nitrate.

But so soon as nitrite is thus formed by the sodium, it itself begins to suffer reduction, as well as the remaining nitrate, by the action of more sodium. This reduction of the nitrite is rendered evident by the effervescence which attends it, the gas given off consisting of pure nitrous oxide. If excess of sodium amalgam be gradually added to the nitrate solution, and its action moderated by keeping the vessel containing the mixture in a stream of cold water, the effervescence only becomes very lively when the sodium added has nearly reached the proportion of two atoms to one of the nitrate used. When four atoms of sodium have been oxidised by the solution, the further addition of it is without effect; no more effervescence takes place, and the sodium remains unchanged in the mercury.

The very alkaline liquid which is left by the reaction contains a new salt, though in relatively small quantity—the salt of nitrous oxide.

After neutralising the alkaline liquid by acetic acid, it gives a yellow, pulverulent precipitate with silver nitrate. This precipitate, when thoroughly washed from its saline mother-liquor, is almost as insoluble in water as silver chloride; for hydrochloric acid gives no immediate opalescence with water filtered through it. It is quite stable below 100° C., or a little lower than this, and it may be washed with hot water without change. It is also unaffected by light, or by exposure to a pure atmosphere, even when in contact with paper. It is but very sparingly soluble in acetic acid; so that this acid may be added in excess to the original alkaline liquid without removing its property of being precipitated by silver salts. It is soluble in ammonia and ammonium carbonate, from solution in either of which it can be again thrown down by acetic acid, or by cautious neutralisation of the ammonia by dilute nitric or sulphuric acid, or by the volatilisation of the ammonia. It is soluble in either dilute nitric or sulphuric acid, and without immediate decomposition; and it can be re-precipitated from its solution in either of these acids by the cautious addition of ammonia or ammonium carbonate, or by the free addition of sodium carbonate or sodium hydrate, in either of which it is insoluble. It is immediately oxidised by concentrated nitric acid, copious red fumes being produced. Moderately diluted nitric or sulphuric or hydrochloric acid decomposes it, with the evolution of nitrogen, and apparently the production of both nitrous and nitric acids in the solution. It is also decomposed by soluble chlorides and by hydrosulphuric acid. When precipitated from the original liquid, it sometimes becomes dark-coloured; but this change is due to the formation of a black matter derived from the sodium or naphtha and the silver acetate. After washing it, dissolving it in very dilute nitric acid, and filtering the solution, it may be re-obtained by the cautious addition of ammonia, or by the addition of ammonia to alkaline reaction and then a little acetic acid, in a condition in which it is no longer liable to discolouration. It is decomposed by a moderate heat into nitric oxide, metallic silver, and a little silver nitrate — in this respect resembling silver nitrite. My experiments on silver nitrite, about being published, show that nitric oxide may serve as a carrier of atmospheric oxygen to silver nitrite; and it is therefore most probable that in this case also some of the nitric oxide liberated serves to carry a little oxygen to the still undecomposed new silver-salt. During its decomposition by heat it does not fuse or exhibit any other change except that from a bright yellow to a silver-white colour. After a red heat nothing remains but pure silver.

The percentage numbers for the silver found and that required by the formula—NOAg—leave no doubt as to the composition of the salt, although the silver comes out about one per cent too low. But in several of the samples traces of brownish or black matters were detected on solution; and in the last preparation analysed the presence of a little moisture was detected; and a further heating of some of it not used for analysis to dry it more thoroughly caused decomposition to commence.

If the product of the ultimate action of sodium on the nitrate be treated with acetic acid, as directed, until it is neutral to test-paper, it gives no precipitate with any metallic solution except that of silver, so far at least as trial has been yet made. But the precipitation of the silver-salt leaves the solution of an acid reaction to litmus; and even if the solution before precipitation be rendered a little alkaline to litmus, it will, after precipitation, generally react slightly acid. The reason of this is clearly that the sodium salt has a markedly alkaline reaction on litmus; and this is shown to be the case by adding some of the washed silver-salt to a solution of potassium or sodium chloride, which it at once renders alkaline in reaction to litmus. To obtain a solution of the salt free from acid or caustic alkali, the original alkaline liquid is to be treated

* Abstract of a paper read before the Royal Society, April 19th, 1871.

with acetic acid in successive quantities until it just ceases to yield a brown precipitate with silver nitrate. Such a solution will yield the yellow silver-salt with silver nitrate as before, and also precipitates with the salts of most of the common metals. Instead of acetic acid, dilute nitric acid may be used in this method for thus neutralising the caustic soda, with the same result as to the alkalinity of the solution to test-paper, and its capability of being precipitated by many metallic salts.

The following reactions having as yet been only observed with a solution thus obtained, it is possible that some of them may not be due simply to the new acid.

Barium chloride gives no precipitate.

Lead acetate gives a cream-white flocculent precipitate, which generally, on standing, changes to a very dense, full yellow precipitate. This precipitate is unchanged by boiling in water, or in its mother-liquor, is soluble in acetic and other acids, slowly, if at all, affected by ammonia or sodium carbonate, and instantly decomposed by caustic soda.

Mercuric chloride gives a cream-white flocculent precipitate.

Mercurous nitrate gives a blackish grey precipitate, not improbably a mixture of mercury and the mercuric salt.

Cupric sulphate, a yellowish olive-green flocculent precipitate, soluble in acids and ammonia, dissoluble in caustic soda, and unaffected by boiling in water or its mother-liquor. The colour of this precipitate closely resembles the colour of a copper salt mixed with a nitrite.

Zinc chloride gives a white precipitate.

Manganese chloride gives a whitish precipitate.

Nickel chloride gives a greenish, almost white precipitate.

Cobalt nitrate gives no precipitate (?).

Alum gives a white precipitate.

Ferric chloride gives a slight reddish-brown precipitate.

Ferrous sulphate gives a whitish precipitate, instantly darkening to dirty blackish green, and eventually reddish brown. On addition of ferric chloride effervescence slowly commences, and with ferrous sulphate the same thing happens, but still more slowly. It is very probable that the iron and aluminium precipitates are simply hydrates; and if so, the action of this salt closely in these cases resembles that of a carbonate.

Silver nitrate behaves as already described.

Sodium chloride gives an alkaline solution with the silver-salt, which is changed to chloride.

Ammonium chloride gives the same result as sodium chloride, but the solution at once evolves ammonia. The existence, therefore, of the ammonium salt of the new acid is problematical.

Potassium permanganate gives the beautiful changes of colour, from its own violet through purple, blue, and chrome-green to manganate green, and then a brown precipitate. The exhibition of this series of colours is more certain in the presence of a little caustic alkali. In this reaction the new salt resembles a nitrite, but it is much more sensitive than this.

Potassium iodide gives no reaction; it does with nitrite.

Iodine solution is decolourised immediately; so that if a nitrite, not in excess, is added to a solution of the new salt, the addition of starch and potassium iodide produces no reaction.

The solution acidified with acetic or hydrochloric acid still gives no reaction with *potassium* iodide, and decolourises iodine solutions, and prevents the action of a nitrite on an iodide.

The acidified solution gives no colouration with ferrous sulphate. In contact with strong sulphuric acid, the mixture gives the colouration like a nitrate does. As is well known, a nitrite, even without addition of acid, gives an immediate colour with ferrous sulphate.

The acidified solution immediately decolourises *potassium permanganate.*

The acidified solution does not reduce *potassium dichromate.*

The solution which has been neutralised with nitric acid instead of acetic acid, will not do for the iron and iodine tests, as this behaves, so far as it has been tried, as if it contains a nitrite.

The acidified acetic acid solution, when heated, evolves *nitrous oxide.* Here again, therefore, the new salt is analogous to a carbonate—$2NOH = N_2O + OH_2$.

When silver nitrite is heated until a greenish yellow, semifused mass remains, and this is washed out with water, the residue consists of metallic silver and a little bright yellow matter, unaffected by light, soluble in ammonia, and decomposed by boiling in water, as will be found described in my paper on the action of heat on silver nitrite already referred to. From the properties of this yellow substance, and from the manner in which it is formed, it is probable that it is the silver-salt of the new acid; but in consequence of the small quantity of it obtainable, and of the admixture of this with metallic silver, a fuller examination of it has not been attempted. If it be this salt, its formation is analogous to that of silver nitrite by heating silver nitrate.

There is some difficulty in selecting an appropriate name for the new acid. That of hyponitrous acid naturally suggests itself as being framed according to the usual method of naming a rising series of oxygen acids, and as associating the new acid with the similarly-constituted acid of chlorine. But I feel that in naming the nitrous-oxide acid regard ought to be had to the possible existence of salts of nitric oxide (which several chemists have believed in), and on better evidence, I think, after a perusal of some of their papers, than is generally supposed. Now, if the nitric-oxide acid should be discovered, and if the term "hyponitric" is to be retained for the acid intermediate to the nitrous and nitric acids, the term "hyponitrous" would belong by analogy to the nitric-oxide acid rather than to the new acid.

This difficulty, however, will vanish if the term hyponitric be allowed to fall out of use, and that of nitroso-nitric, already adopted by several chemists, be generally substituted for it as the name of the nitrogen-peroxide acid; for then the term "hyponitrous" being given to the new acid, there remains the compound term "hyponitroso-nitrous" for the nitric-oxide acid, should this acid ever be obtained.

There will thus be the following series of names:—

Hyponitrous acid	HNO
Hyponitroso-nitrous acid	$H_2N_2O_3$
Nitrous acid	HNO_2
Nitroso-nitric acid	$H_2N_2O_5$
Nitric acid	HNO_3

If, however, the terms "hyponitrous" and "hyponitric" are to be retained for the second and fourth members of the above series, the term "hydro-nitrosylic" may serve for the new acid, according to its constitution.

Hydrogen.	Nitrosyl.
H	NO

ON BOILED OILS AND VARNISHES.*

By CHARLES W. VINCENT.

(Concluded from page 199.)

The risk of boiling over, and being the cause of a conflagration, was one reason for the distance at which oil-boiling businesses were formerly kept from towns; the abominable smell produced by the evaporation and partial decomposition of the oil was another. Nevertheless, it is not convenient, in the extension of businesses of a disagreeable character, to be constantly driven from the centres of industry, where their articles of manufacture have ultimately to be used, and this has been particularly the case with the oil trade. In a place like London, a very large

* Read before the Society of Arts.

part of the consumption of boiled oil must be local; or if the oil be exported it is the same thing as far as the manufacture is concerned, each mile he is driven away from his customer decreasing his profits, without any corresponding advantage. It became, therefore, a matter of absolute necessity that means should be taken to stop the intensely disagreeable smells arising from oil-boiling tainting and poisoning the air of the surrounding neighbourhood. This has been arrived at in a perfect manner, as an adjunct of the steam process.

The best form of pan for oil-boiling is made of copper, on account of its conducting heat better—an iron one will give equally good results, a little more time being, however, required—circular in shape, with a depth about equal to its diameter, and a rounded bottom. This pan is surrounded for half its depth with an iron jacket, between which and its body steam is admitted as the source of heat.

The jacket and pan should be capable of standing a working pressure of 40 lbs. per inch. The top of the pan is closed by a dome rivetted to it and forming part of it. This dome is provided with a man-hole, and in the centre is furnished with a stuffing-box, through which pass two shafts, one encircling the other, and each bearing a fan, which fan, by gearing outside the pan, are made to rotate in opposite directions, intersecting each other in so doing, and, as may be conceived, producing a most thorough admixture of any solid and fluid substances submitted to their dashing and cutting action. At one side of the top of the dome is a kind of cupola, from the top of which issues a three-inch pipe, which is carried down to the ash-pit below the boiler furnace. When at work, care is taken that every joint is tight, hence any vapours arising in the interior of the pan have no chance of escaping into the air till they have passed the burning coals. One of the greatest dangers and also disagreeable nuisances being thus obviated, oil-boiling can be and is carried on without objection on the part of either the insurance companies or the public at large, even in the heart of densely-populated districts. I myself boiled oil and made varnish in Milford Lane, Strand, for three years, without increasing the insurance of the *Illustrated London News*, though I used steam from their boilers for the purpose.

At the lower part of the pan, the inch-pipe from a powerful air force-pump penetrates through the jacket to the interior of the pan.

The workman's first care is to see that all his taps and valves, are in good, efficient order, and turned the right way, after which the mode of manipulation is the following:—

The linseed oil is first shot into a large tank, holding one batch for boiling (about 2 tons is the usual quantity), and allowed to settle for four or five hours, according to the time taken for boiling the previous batch, matters being so arranged that as soon as one batch is pumped up into the pan another is shot into the tank, so that the oil may have as long a time for freeing itself from mechanical impurities as can be spared for that purpose. The waste steam from the pan passes through a coil of inch and a half iron pipe placed in this tank, so that the oil is also being warmed—this much facilitating the separation of particles of dust, mucilage, &c., and also saving time when the actual boiling commences. The time having arrived when the pan is ready, the oil has acquired a temperature of about 95° F. before it is pumped up (in the works I am describing the arrangement of pumps used took about seven minutes to elevate 2 tons of oil 20 feet), full pressure of steam is then turned on the pan, and the fan started. At first there is little or no disagreeable smell to be perceived. If the man-hole of the pan be open, an observer can watch the oil churning round with very little frothing, although the blades of the two fans, rotating in opposite directions, cause such a perfect commingling of the oil and the air that is in the upper part of the pan, that looking in upon the whole fluid mass, it seems as if the bulk were greatly increased, as it goes on swelling and chafing, with a hollow rumbling noise, at the rough treatment it is receiving. A few minutes later, a faint, sickly odour is to be perceived, something like the smell of the raw oil, but intensified as to its woody constituents. The oil is now nearly hot enough for the air to be turned on. This may be done as soon as the steam reaches a pressure of 35 lbs. to the square inch on the pan. Directly this is done, the character and the appearance of the oil changes; the bulk appears to be still more increased, a foaming, seething, whirling vortex presents itself, the colour suddenly changes from the dark brown it previously exhibited to a mass of pale yellow bubbles, and the strong pungent odour universally accompanying the boiling of oil makes itself known and felt by the discharge from eyes and nose, if the curious observer does not take the hint that it is time the man-hole was closed, and the cauldron left to complete its witchery in darkness and solitude, if not in silence. But before it is left to itself, it may be well to observe that, before the air was turned on, a taper would burn in any part of the space above the oil where it was safe from being extinguished by splashes. After the air has been blown through the oil for a short time, if both the flue and air-pumps be stopped, so that a perfectly quiescent atmosphere remains above the oil, it is found to be perfectly incapable of supporting combustion. A few inches inside the man-hole, I have found that a brown paper torch, dipped in turpentine, has been immediately extinguished.

If a dark boiled-oil is desired, the driers should be put in as soon as the oil is thoroughly heated throughout its bulk, which is commonly about half an hour after the steam has an indicated pressure of 35 lbs. They are ground to a fine powder, mixed with oil, and are introduced through a funnel with a stop-cock intervening between it and the pan, in a thin stream, so as to secure as perfect a distribution of them as possible throughout the oil. The quantity of driers used amounts only to about three quarters of a pound to each hundred weight of oil, so that the necessity is obvious of great pains being taken to secure and maintain as complete a diffusion through the liquid as can be attained, and thus coincide with the theory of this method of oil-boiling, which requires that each particle of oil should be in contact or proximity to a particle of the drier used and oxygen at one and the same time.

Subsequent to the introduction of the driers, no attention is required to the process save to see that the air-pump and fan are kept constantly at work, and that the pressure of steam on the pan does not sink at all below 30 lbs.; 35 lbs. being that which ought to be adhered to. The right quantity of air to be introduced for the oxidation of a given quantity of oil has not been ascertained. In practice, it is found that some oils require, and will consume, a larger amount than others; the custom is to throw in as much as the oil will take without frothing up and priming into the condenser. The cooling effect of the air thus introduced is much less than might be supposed; in point of fact, the pressure to which it is subjected in overcoming the weight of the oil, lifting the heavy valves, and the friction tubes it passes through, considerably raises its temperature before it enters the pan; it is generally found to be raised some 20° to 30° above the temperature it previously had by the time it reaches the oil. Indeed, the tubes through which it passes not unfrequently become hotter than the bare hand would be able to hold in a firm grip. In four hours' time the oil is generally fit for removing from the pan to a tank, where it can remain a sufficient time for the major part of the driers to settle out from it. When bright, it is then either pumped or run off into other tanks for warehousing, or may be allowed to remain where it is for future use, if there are plenty of working tanks.

The mode of emptying the pan is by allowing the oil to rush out through a two-inch tap in the centre of the bottom of the pan into pipes which are connected by running joints, and lead it in any desired direction.

Sometimes a little difficulty occurs in dropping the oil, through the orifice of the tap leading into the pan becoming stopped up by an accumulation of driers, or by pieces of the old skins of oil which may have fallen from the sides of the pan. This may be entirely obviated by causing the air to enter the pan through this tap, and putting the second tap beyond the air inlet as an outlet for the oil. The pressure of the air-pump will then suffice to remove any ordinary obstruction; but if a stoppage, nevertheless, should occur, nothing remains but to probe the tap with a long thin rod from the top of the pan. Until this simple expedient of letting in the air through the oil outlet was adopted, this terrible nuisance was of almost daily occurrence.

The vapour which comes off from hot oil into which air has been blown is so intensely acrid and pungent that human nature seems to be incapable of ever getting used to it. For my own part, I would much prefer entering a freshly-opened bleaching powder chamber to an oil-pan, even after the oil has been run off, and the pan cooled down. There was no task in the works more thoroughly abhorred than that ten minutes to a half-an-hour, occasionally longer, during which, with the man-hole open, the workman was raking and poking between the radii of the fans to clear and find the outlet. With this now happily occasional exception, and for the few minutes during which the hot oil is being transferred from the pan to the tanks, this method of oil-boiling produces no disagreeable smell in the vicinity, the fumes being carried away with the surplus air-pump through the oil, and perfectly consumed, so far as noxious odour is concerned, in the furnace of the boiler. Members of this Society have frequently the opportunity of witnessing the efficacy of the operation of this process during some of the lectures delivered here, the air of this hall being kept free from troublesome fumes by a similar arrangement. From this paper the chemical questions involved must be, for the most part, excluded, as it would be scarcely possible for me to enter far into the subject without betraying confidence, the driers used and their *modus operandi* being essentially connected. I may state, however, that the air does not play the part which many have assigned to it, and does in reality effect nothing towards making the oil a drying one. I have boiled linseed oil with air alone, but without driers, for three days consecutively, keeping up a high temperature the whole time, and the resultant boiled-oil has taken precisely the same time to dry as the raw oil from which it was prepared. The body, however, has so much increased that the consistency was more that of a varnish than an oil.

If oil be subjected to heat alone for the same space of time, without any air except such as comes in contact with its surface, there is no such increase in consistence as in the former case; the oil simply becomes more greasy, has less difficulty in penetrating capillary tubes (as, for instance, those of paper, plaster, &c.) than it previously had, and has decidedly less drying powers. The oil which has been boiled with air is less greasy and has a greater consistence. To sum up the process in a few words, I think we show we have the means at hand of meeting all the requisites which were stated to be necessary. The close apparatus in which the work is performed secures the manufacturer alike from annoying his neighbours and injuring his own men. The air and heat secure a sufficient amount of body. The driers produce any required shade of colour. The time of drying *i.e.*, about six hours in summer, and eight hours in winter, according with the old standard of drying power. Oil can be made to dry in much less time, but this is not considered to be desirable. The mechanical appliances reduce the time of the operation to about one-fourth of that which in former years was thought essential. In the ordinary working day, starting with cold oil and a cold boiler, two batches, of two tons each, can be boiled without causing undue driving of men or machinery.

Before leaving this part of the subject, it may be as well to note, that for boiled-oil which has to be exported, long experience has shown that it is advisable in all cases to add to each barrel or drum of boiled-oil a small proportion of raw oil. After a one or two months' voyage the oil becomes brighter than it was when first shipped, and the risk of becoming what is called "fatty," and not free enough in working, is thereby avoided. For a three months' voyage, one gallon of raw linseed may be added to each four gallons of boiled-oil with most beneficial results, particularly if the boiled-oil be anything under one month old.

Varnishes.

As you all know, the main uses to which varnishes are applied are to protect the material over which it is spread from atmospheric influences, accidental rough usage, &c.; to bring out and display more fully the varying texture of different woods; and, finally, to give a fine gloss or appearance of polish to the surfaces to which it is applied. As commonly constituted, an oil varnish (and with these alone I propose to deal) consists of some hard gum dissolved in linseed oil. This is the substance of the varnish, the two being re-dissolved in turpentine to afford the means of spreading them out in thin layers. As far as regards the ultimate value of the varnish, the turpentine is merely so much waste material. It may, if it be of inferior quality, injure the varnish with which it is mixed, but however good it may be, it can do nothing to benefit or improve a varnish which itself is in reality nothing but the mixture of various proportions of some one or more hard gums in linseed oil.

For the convenience of better understanding the *rationale* of the mode of precedure, it will be well if we commence our observations at the end instead of beginning of the process.

Turpentine, being applied for the purpose of thinning down the body of the varnish, and that body being, when cold, almost solid, has to be added whilst the mixture of gum and oil is still hot. The heat causing an increased evaporation, and consequently a loss of turpentine, the temperature is allowed to get as low as can be, consistently with a perfect and complete admixture of the spirit with the matter being secured. This is, to some extent, contrary to old-fashioned notions, but the varnishes resulting from mixing in the turpentine at a high temperature and at a low one being identical, the loss of so much evaporated material is not now taken as an essential part of the process. We have also one less risk of fire, since the whole varnish is now removed far from any fire, and out into the open air when practicable, before the turpentine is added. The quantity of turpentine required under these circumstances is much less than that stated in the various published recipes for varnish making. Enough is commonly added to bring the whole mixture to a consistence a little stiffer than linseed oil. The loss by evaporation, whilst clearing and ageing in tanks, previous to its being sent out, gives it the amount of body which you are accustomed to see it have. The next thing to consider is the body of the varnish. Time would not permit me to give a complete description of the various gums which are or may be used; I can do no better than refer you to Mr. Neil's paper for information on this part of the subject. There is one gum, however, which has come very largely into use since his time, and that is the "kauri," New Zealand gum. It is rather dull in appearance, but it is tolerably hard, and melts at so low a temperature that the dust and chips made by cleaning the outside of large pieces can be utilised by a skilful man, without the gum being coloured by the carbonisation of the woody matter in it. The varnish made from the better qualities of kauri have a very good gloss. When dry, they are pale in colour; dry quickly, and are not so liable to crack when exposed to the sun as better varnishes. After a few months' exposure to wet, however, the whole of the gloss disappears, and though the

protecting surface remains, it becomes, through its abrasion, a harbour for the dust and dirt, and is thus rendered far from ornamental to the place of its attachment.

The temperature at which the mixture of gum and oil intended to be used melts is now recognised as forming a basis for the temperature to which the oil is to be heated previous to the introduction of the melted gum, the whole running, when the two are fairly incorporated, being also kept much under the degree of heat which was formerly considered necessary. In fact, it is in this respect that the present mode of varnish-making chiefly differs from the modes formerly employed, the greatest care being now taken to keep the temperature throughout the process as low as is consistent with perfect admixture of the several ingredients.

The next point to which I shall direct your attention is the apparatus used for the modern process of varnish-making. In the first place, iron vessels generally take the place of copper ones for all common varnishes, the bottom of the gum pots alone remaining copper, as heretofore. The lower temperature employed is found not to affect the metal, and the introduction of impurities from that source is no longer feared.

In the next place, instead of heavy copper stirrers, light thin plates at the end of the rods are used to cut the gum, &c., the greater velocity with which they can be manipulated securing more perfect mixing than of old.

In the third place, a tramway is laid down from the furnace in which the mixed gum and oil is heated, which usually runs from the shed into the open air. If, therefore, from any accident the mixture takes fire, it can be at once removed to a place of safety, where it can be put out at more leisure.

The boiling pot, which holds about 100 gallons, has a closely-fitting conical cover, which, if it can be put on, at once extinguishes the flame if it be not too far a-head. The last improvement has only recently been introduced, and is not yet generally adopted. Two galvanised iron shafts are erected side by side; one corresponds with the gum pot, the other with the boiling pot; the upper end of these shafts alike communicates with the main furnace shaft. The lower ends are fitted with caps, which are so balanced by counterpoises that they can be slid up or down their respective columns. To these caps heads are attached at right angles, which can be brought over, and which fit closely on to the gum pot and boiling pot respectively, and, when in that position, have free communication with the chimney shaft. The front of each hood is cut away and fitted with a diaphragm, slit in such a manner that the contents of the pots can be stirred, and is removable when it is desired to see into them.

The advantages of this arrangement are obvious without further description; in place of the workmen being annoyed by the dense and pungent vapours which escape from the heated gum and oil, the whole are removed, and nothing whatever comes into the air of the shed except at the time when a pot of the gum is being tilted into the boiling pot, or when the whole has to be removed into the air. The reduction of smell, as regards the neighbourhood, is so great, that in the comparatively rare intervals when a disagreeable vapour does come off, the air of the yard mixes with it sufficiently to neutralise the effect exterior to the works. This latest improvement is due to Mr. Bewicke, of Hackney Wick, who, in consequence of a disastrous fire at his works having been caused in a great measure by the men being so suffocated with the fumes from the boiling pot that they were unable, when it took fire, to extinguish it in time, has been impelled to seek for such more perfect appliances as would bring the whole system more under control than had previously been the case. I think you will agree that the plan deserves to succeed, and, from the experience it has already had, I believe it will do so. Old varnish makers, standing at the furnaces when they are in full operation, seem at first almost at a loss to know what stage of the process they are at, from the want of their accustomed choking miasma.

ON IMPROVEMENTS IN THE MANUFACTURE OF CHLORINE.*

By WILLIAM ODLING, M.B., F.R.S.,
Fullerian Professor of Chemistry, Royal Institution.

CHLORINE gas was first obtained in 1774, by the Swedish chemist, Scheele, as a product of the action of muriatic acid—or marine acid, as it was then called—on the black earthy mineral manganese. In accordance with the theoretical notions of the day, Scheele gave to his newly-discovered aërial substance the name dephlogisticated marine acid, which, translated into the language of the new Lavoisierian school, became soon afterwards oxy-muriatic acid. Its assumed constitution and relationship to muriatic acid are indicated below.

Muriatic acid.

Hydrogen — Chlorine.

Hydrogen + Oxygen. — Murium + Oxygen.

Water. — Hypothetic dry muriatic acid.

But Davy, in 1810, showed that muriatic acid gas is a substance wholly free from water, and a definite compound of Scheele's gas with hydrogen. He showed further that Scheele's gas, the so-called oxy-muriatic acid, was not only incapable of furnishing oxygen under any circumstances whatever, but that, so far as experience went, it was altogether undecomposable. Being thus an undecompounded and apparently undecomposable substance, he proposed to regard it as an element, and to designate it, from its yellowish-green colour, by the name chlorine, which it has ever since borne. After considerable opposition, especially on the part of Berzelius, who subsequently, however, became a convert, the view of Davy at length prevailed, and has ever since held its ground, not, indeed, without occasional challenging from time to time. Thus Schönbein, in several of his letters to Faraday, maintained very strongly the superior truthfulness of the original view; and still more recently Brodie has represented the comparable units of hydrogen, H_2, muriatic acid, HCl, and chlorine, Cl_2, by the symbols α, $\alpha\chi$, and $\alpha\chi^2$, implying that the units of muriatic acid and chlorine differ from the unit of hydrogen by a combination of the matter of α with the matter of χ and with the matter of χ^2, respectively. But whatever may hereafter prove to be its real nature, chlorine has hitherto proved undecomposable, and is accordingly regarded by the generality of chemists as an element.

Coincident with the discovery of chlorine itself was the discovery of its most characteristic property, that of bleaching vegetable colours. The petals and leaves of plants, infusions of their several colouring matters, as well as fabrics dyed with the several colouring matters, were found to be rapidly bleached when treated either with chlorine gas or with a solution of the gas in water. From the rapid action of the gas and its solution on pronounced vegetable colours, Berthollet, in 1785, conceived the notion that chlorine in one form or other might be used with advantage commercially for the bleaching of calicoes and linens, theretofore always bleached by a tedious exposure to air and sun-light. The processes devised by Berthollet for carrying out the new method of bleaching were introduced into Scotland in 1787, and soon afterwards became extensively employed. Woven fabrics were bleached by immersion in chlorine water, and paper-pulp more especially by exposure to chlorine gas.

The bleaching action of chlorine takes place only in presence of water or moisture, and is dependent on the property of chlorine under suitable circumstances to decompose water, by uniting with its hydrogen to form muriatic acid, and so setting free its oxygen, by which the bleaching is really effected. Thus, when chlorine, blue

* A Lecture delivered before the Royal Institution of Great Britain January 27th, 1871.

indigo, and water are present together, the opposite tendencies of the chlorine to take hydrogen, and of the indigo to take oxygen from the water, are satisfied by the production of chloride of hydrogen or muriatic acid on the one hand, and of oxide of indigo or isatin on the other, this isatin being a soluble orange-red non-tinctorial body:

$$Cl_2 + H_2O + C_8H_5NO = 2HCl + C_8H_5NO_2.$$

Thus, bleaching by the action of chlorine, like bleaching by exposure to air, is really an act of oxidation.

But the action of chlorine on vegetable fabrics is not confined to that of bleaching their attached colouring matter; the fibre of the fabric is itself liable to be attacked both by the free chlorine and the muriatic acid to which it gives origin. Hence it became important to find a substitute for the free chlorine which should have, like it, the property of liberating nascent oxygen so as to bleach, but should not have, at any rate in the same degree, the property of corrosiveness so as to destroy. Such a substitute is offered in the familiar compound known as bleaching powder, introduced into commerce by the Messrs. Tennant, of Glasgów, in the year 1799. This substance is made by exposing slaked lime to an atmosphere of chlorine gas. The chlorine enters into combination with the lime of the slaked lime, to furnish a product which in practice contains some 35 per cent of its weight of chlorine, and consists of a definite compound of lime with its own weight of chlorine, plus a variable excess of slaked lime unacted upon—

$$CaO.H_2O + Cl_2 = CaOCl_2 + H_2O.$$

Bleaching powder occurs as a dry white pulverulent solid, having a characteristic smell, allied to but not identical with that of weak chlorine. It dissolves considerably in water to form a yellow-tinted liquid known as bleaching liquor, having a marked alkaline reaction from the presence in it of excess of lime. Coloured goods immersed for a longer or shorter time in bleaching liquor of greater or less strength and temperature, gradually have their colouring constituents destroyed or oxidated, the bleaching salt $CaOCl_2$, losing its oxygen, and becoming changed into chloride of calcium, $CaCl_2$. It is observable that the bleaching or liberation of nascent oxygen from bleaching powder is much slower than the bleaching or liberation of nascent oxygen by means of free chlorine; to such an extent, indeed, that for many purposes bleaching powder would be quite inapplicable, were it not for the property it has of liberating chlorine on acidification, whereby a still indirect but yet almost immediate oxidation is effected. Ten grains of bleaching powder, for instance, mixed with a little sulphuric or muriatic acid, will evolve some 4 cubic inches of chlorine gas—

$$CaOCl_2 + H_2SO_4 = H_2O + Cl_2 + Ca''SO_4.$$

The superior activity of the chlorine liberated by acidification of bleaching liquor to the original bleaching liquor is taken advantage of commercially. Brown linens, for example, are first steeped in weak bleaching liquor with little apparent result, and then "soured" by immersion in dilute acid, whereby an immediate more or less complete bleaching is effected. Again, in what is known as the "discharge style" patterns or designs are printed with a mixture of gum and tartaric or other acid, upon a red or blue ground, and the printed fabric passed through a solution of bleach. The red or blue ground withstands the feebler action of the bleach, but the acid printed pattern becomes completely decolourised by the chlorine set free locally, as a result of the action of the acid upon the bleach. It is to this facility of management and capability of being used in different ways that the great utility of bleaching powder and its consequent enormous consumption are due. The amount of bleaching powder made annually in Great Britain and Ireland at the present time is estimated at 75,000 tons, representing at the price of £10 a ton, a value of three-quarters of a million sterling.

Bleaching powder being formed by exposing slaked lime to an atmosphere of chlorine, the manufacture of bleaching powder involves the production of chlorine. Indeed, chlorine is produced at chemical works almost exclusively for the manufacture of bleaching powder, and of one other product, namely, chlorate of potash. This latter is made to the extent of about 750 tons yer annum, having at the price of £105 per ton, a value of nearly £80,000 sterling.

The original reaction upon one another of muriatic acid and peroxide of manganese, by which Scheele was led to the discovery of chlorine, is the basis of the manufacturing process which has ever since been almost exclusively followed. The action consists essentially in the excessive oxygen of the peroxide taking away the hydrogen of the muriatic acid and so setting its chlorine free. Peroxide of manganese, more often called simply manganese, is one of that very limited class of native mineral substances containing an excess of oxygen; the only other similarly peroxidised substance abundant in nature being nitre, in its two forms of East-Indian or potash-nitre, and Chilian or soda-nitre. Now, when muriatic acid instead of being acted on by manganese is acted upon by nitre, or by the nitric acid, formerly known as spirit of nitre, produced therefrom, the excessive oxygen of the nitre takes away hydrogen from the muriatic acid and sets its chlorine free. Thus, by addition of nitric acid or nitre to aqueous muriatic acid, a solution of chlorine is produced, recognisable in various ways, and especially by its power of dissolving gold leaf. Now, although nitre or nitric acid is a much more expensive oxygenant than manganese, it was conceived that nitric acid might nevertheless be substituted with advantage for manganese, from the circumstance that, after it had given up its excessive oxygen so as to liberate the chlorine of the muriatic acid, its deoxidised residue could readily acquire fresh oxygen from the atmosphere, and so reproduce nitric acid, to be used as an oxygenant over and over again indefinitely; and indeed, the nitric method of producing chlorine has, for some time past, been, to a limited extent, in actual use.

With regard to manganese, however, until recently no means have been known of causing its deoxidised residue to re-acquire oxygen from the air, and so become in a condition to serve again for the liberation of chlorine. From time to time, more particularly by Messrs. Tennant and Mr. W. Gossage, attempts have been made in this direction, some of them so far successful as to achieve a limited adoption; and at length a process of reviving the spent manganese residue by effecting its aërial oxidation, has proved a decided commercial success. This process, introduced by Mr. Walter Weldon, has the incidental advantage of doing away with the discharge of the extremely corrosive manganese liquor into streams and watercourses, whereby great damage was frequently occasioned. It consists substantially in neutralising with chalk the acid liquor left by the action of the muriatic acid on the manganese, and then pumping air through the neutralised liquor mixed with excess of lime. The original acid liquor is substantially a solution of chloride of manganese with perchloride of iron, chloride of aluminum, chloride of calcium, and the excess of chloride of hydrogen, or muriatic acid, employed. By neutralisation of the acid liquor with chalk, the iron of the perchloride of iron is precipitated, and a pale pink manganous solution left. By treatment of this solution with milk of lime, an almost white precipitate, consisting of hydrated protoxide of manganese with excess of hydrate of lime, is thrown down. Then by blowing air through the resulting thin sludge, raised to the temperature of 140°—160° F. by injection of steam, oxygen is rapidly absorbed, and the sludge rendered of a deep black colour. By subsidence the now black sludge yields a dense deposit, from which the supernatant clear liquid is run off. Finally, the deposit in its moist condition, and containing in every cubic foot about four pounds weight of peroxide of manganese, is acted upon by muriatic acid in the chlorine stills, and the resulting acid liquid treated over again in the same way, and so on indefinitely.

Already the Weldon process of manganese restoration is employed and about to be employed at many large works, to such an extent, that before very long one-half of the entire quantity of bleaching powder produced in the kingdom may be expected to be made with chlorine generated by means of the restored manganese. It is noteworthy that the original pale precipitate of hydrated protoxide of manganese undergoes oxidation very imperfectly save in presence of a considerable excess of lime, and that the black product finally obtained is not simply peroxide of manganese, MnO_2, but a compound of the peroxide with lime, of composition varying in different instances between that indicated by the respective formulæ $CaO.MnO_2$ and $CaO.2MnO_2$, a small portion of the lime, CaO, being usually replaced by its equivalent of protoxide of manganese, MnO. Some idea of the rapidity of oxidation effected under favourable circumstances may be gathered from the following result: Of the entire quantity of oxygen contained in 175,000 cubic feet of air blown into the sludge within five hours, 14·8 per cent, equal to rather more than 4 cwts., was absorbed in the production of 22 cwts. of manganese peroxide, MnO_2. It is obvious that where Weldon's process is carried out, what happens is this:—The original peroxide of manganese first oxidises a quantity of muriatic acid, and sets free its chlorine. Then the spent manganese is caused to acquire a fresh dose of oxygen from the air, and is used to oxidise a fresh quantity of muriatic acid, and so on continuously. Thus, except during the first use of the manganese, the muriatic acid is really oxidised by the oxygen of the air, the manganese serving only as a carrier. Latterly, Mr. H. Deacon, of the Widnes Alkali Works, has conceived the idea of dispensing with the carrier—that is the manganese—altogether. It has been known for some time that when muriatic acid vapour mixed with air is passed through heated tubes, the oxygen of the air effects a partial oxidation of the muriatic acid, setting free its chlorine; but the reaction is not sufficiently complete to render the process commercially available. Mr. Deacon, however, has ascertained that when a mixture of air and muriatic acid vapour, heated to about 700° F., is passed over a mass of brickwork that has been steeped in solution of sulphate of copper and afterwards dried, an almost complete decomposition of the muriatic acid is effected. The copper salt certainly takes part in the reaction as an intermediary, but in the end is quite unaffected, the sole obvious result being that the chlorine of the muriatic acid is set free by the oxygen of the air, with a rapidity which seems to leave nothing to be desired. The nature of the intermediary action exerted by the copper salt, so ingeniously made serviceable by Mr. Deacon, has not been clearly ascertained. It would appear, however, that by two simultaneous reactions taking place continuously throughout the process, chloride of copper is ever being alternately formed and decomposed; it being remembered that chloride of copper gives off a portion of its chlorine with much facility, even by heat alone. The extreme result would, probably, be somewhat as follows:—

$$CuCl_2 + O = CuO + Cl_2$$
$$CuO + 2HCl = CuCl_2 + H_2O.$$

Although this new process has not yet been worked on a manufacturing scale, considerable experience has been acquired with regard to it, and the difficulties to which it at first seemed liable have been successfully provided against. One inevitable difficulty arising from the diluted state of the produced chlorine, has proved to be less serious than was anticipated. This state of dilution is at all times considerable; for the chlorine being generated by the action of atmospheric oxygen on muriatic acid, every volume of chlorine produced, even in an absolutely perfect working of the process, must be necessarily diluted with twice its volume of atmospheric nitrogen. Nevertheless, according to Mr. Deacon's experience, the diluted state in which the chlorine is always obtained has not been found to interfere with its application to the manufacture either of chlorate of potash or bleaching powder. The requisite plant for carrying out the invention on a large scale is now being erected at Messrs. Gaskell and Deacon's works.

For experimental purposes the new process of continuous chlorine production may be performed with oxygen instead of air. It then manifests a striking reverse relationship to a process of continuous oxygen production, in which oxide of cobalt acts as a permanent intermediary.

In the one experiment the gas goes in oxygen and comes out chlorine, muriatic acid being decomposed and water formed. In the other experiment the gas goes in chlorine and comes out oxygen, water being decomposed and muriatic acid formed. In the presence of slaked lime to arrest the muriatic acid, this last reaction takes place readily and completely below the boiling-point of water.

NOTICES OF BOOKS.

Chemisches Apothekerbuch: Theorie und Praxis der in Pharmaceutischen Laboratorien Vorkommenden Pharmaceutisch, Technische und Analytisch-Chemischen Arbeiten. Von Adolf Duflos, Docteur der Philosophie und Medicin, Königlichem Geheimen Regierungs-Rathe und Professor. Fünfte Bearbeitung. Nebst Hülfstabellen für die praxis in pharmaceutischen laboratorien und vergleichen der uebersicht der nomenclatur der arzneilich angewandten chemischen präparate der Pharmacopœa Germaniæ, oder Pharmacopöen von Preussen, der Schweiz, England, Frankreich, und Russland, wie der von Hanover, Hessen, und Schleswig-Holstein. Mit 180 in den text gedruckten abbildungen nach original zeichungen und einem spectralbilde nach Bunsen und Kirchhoff. Ferdinand Hirt, Verlags und Königliche Universitäts Buchandlung, Breslau. 1867.

Chemical Apothecaries' Book: Theory and Practice of the Pharmaceutical, Technical, and Analytical Operations and Work to be performed in Pharmaceutical Laboratories. By Adolf Duflos, M.D., Ph.D., Privy Councillor of His Imperial and Royal Majesty of Germany and Prussia, and Professor at Breslau University. Fifth edition, thoroughly re-written and revised; to which are added tabular forms for assisting in the practice of the pharmaceutical laboratory, and a comparative review of the nomenclature in use for the chemical preparations which are officially prescribed by the Pharmacopœæ of Germany, Prussia, Switzerland, England (Ph.B.), France, Russia, Hanover, Hesse, and Schleswig-Holstein. Illustrated with 180 woodcuts, made from drawings expressly prepared for this purpose, of apparatus in actual operation, and also coloured spectra according to Bunsen and Kirchhoff. Ferdinand Hirt, Breslau. 1867.

It is gratifying to us to have the opportunity of once more bringing under the notice of our readers a work of so illustrious and no less modest a *savant* as Dr. Duflos. We say modest, because it should be understood that under the title above quoted the author has produced a compendium of chemistry, theoretical, practical, applied, and analytical, such as no other exists in any language. The work is professedly written only as a guide-book for pharmaceutists, but we can readily show our readers that this book is really a *vade mecum* for all classes of chemists, the author's practical experience of the laboratory extending over fully half a century.

The first ninety pages of the work are devoted to physical chemistry, including a very excellent and readable chapter on crystallography, copiously illustrated by woodcuts, and containing, for every crystalline system, an enumeration of the common minerals and a large number of chemical preparations which belong to it. The theory of chemistry, equivalents, atoms, allotropy, isomery, &c., is very lucidly set forth, and is followed by a short chapter on the origin and decomposition of compound bodies, fermentation, ferments, decay, contagion. The

next large division of the book is headed "*A-metals*" (*a privans*); under this division are treated oxygen, sulphur, selenium, tellurium, the haloids, phosphorus, boron, silicon, and lastly carbon. It is a noteworthy feature of this work that under carbon are treated, not simply carbonic acid and the other compounds of carbon usually supposed to belong to inorganic chemistry, but there are also introduced those organic compounds which contain carbon and hydrogen, as well as those which, in addition to these elements, contain oxygen; so that the chapter on carbon, some 260 pages, contains a great portion of the organic part of chemistry. Under nitrogen, again, after having treated of the compounds that element forms with oxygen, those of nitrogen and hydrogen are treated of, and immediately after the chapter on the ammonia bases follows the chapter on the vegetable alkaloids, after which the compounds of nitrogen and carbon are treated of, ending with a chapter on uric acid. The large section then following treats on the metals, inclusive of the more rare ones, and not omitting any preparation of even slight importance, while, of course, those used pharmaceutically or industrially are very fully described. It is a prominent feature that minute and careful directions are given for making all the preparations. The chapter on Chemical Analysis treats, in a succinct, but clear manner, on this subject, inclusive of blowpipe testing. There is next added to this work, first, a series of no less than twenty-six tables for various purposes. To quote the full titles of all would occupy far too much of our space, but they commence with a table exhibiting the elasticity and vapour density of aqueous vapour at temperatures from $-20°$ to $+30°$, and end with a tabulated form of the boiling-point of aqueous saline solutions according to the varying quantity of salts therein contained. We next meet with a comparative tabular review of the nomenclature of the chemical preparations officinally used and found in the Pharmacopœæ of Germany, Prussia, Switzerland, England, France, and Russia; and, after that, two similar tabulated reviews bearing upon the French and German Pharmacopœæ, and also the comparison between the sixth and seventh editions of the *Pharmacopœa Borussica* and the Pharmacopœæ of Hanover, Hesse, and Schleswig-Holstein. The last pages of this work are devoted to two indices, one containing the German, the other the Latin names. There is met with at the beginning of the book an excellent descriptive index of all the woodcuts, and thirty-two pages of *addenda et corrigenda*, all proving that the author has spared no pains or trouble to produce, what this work really is, a magnificent bequest to his many pupils.

A Concise View of the Law connected with Letters Patent for Inventions. By JAMES JOHNSON, Barrister-at-Law, and J. HENRY JOHNSON, C.E. London: Longmans, Green, and Co.

THIS little work, condensed from the "Patentees' Manual," by the same authors, certainly fulfils its title. All the leading principles and salient points of Patent Law are explained in as clear and simple a manner as the subject is capable of, while the details of the various Acts of Parliament are left to more pretentious works. The book contains a useful summary of the patent laws of foreign countries and the British Colonies.

CORRESPONDENCE.

ON THE SPECTRUM OF THE AURORA.

To the Editor of the Chemical News.

SIR,—In the last number of the CHEMICAL NEWS some remarks are made by Professor W. A. Norton, on the presence of iron in the spectrum of the aurora. In connection with this subject I may mention that, in a paper in the CHEMICAL NEWS, July 12th, 1867, after alluding to the earth acting by virtue of its magnetic attraction, and drawing to its surface any substances of a highly magnetic character, such as iron, which might approach within the sphere of its influence, I observed that "this would occur mostly in the vicinity of the north and south poles. A large quantity of finely divided meteoric dust descending in this manner into the earth's atmosphere, and becoming ignited therein, might contribute to the phenomena of aurora borealis and australis."—I am, &c.,

JOHN A. R. NEWLANDS, F.C.S.

13, Knowle Road, Brixton,
April 29, 1871.

INTESTINAL CALCULI.

To the Editor of the Chemical News.

SIR,—In your last issue Mr. Stark describes and figures a calculus, the weight of which was a little more than 2 lbs. Whenever he is in London I shall be happy to show him one of these concretions weighing 9½ lbs., and having a circumference of 22 inches. It, also, is from a horse, and is almost entirely composed of phosphate of magnesium and ammonium. Fragments of hair and vegetable fibre have apparently assisted the crystals of the salt in forming a compact hard mass; the motion of the animal, in walking, probably still further solidifying and rounding the ball. A section of the stone shows it to be built of a series of concentric strata, varying in colour from dirty white to dark brown, the tints depending on the different amounts of organic matter in the several layers of mineral deposit. The nucleus on which the calculus has been formed, in this instance, is a small piece of flint, and the section has been so made as to exhibit the pebble *in situ*.

These calculi are not unfrequently found in the intestinal canal of herbivorous animals. At the Pharmaceutical Meeting at which my specimen was shown, some eight or nine years ago, Dr. Edwards remarked that in the Liverpool Museum there were two such stones, weighing respectively 11 lbs. and 13 lbs.—I am, &c.,

JOHN ATTFIELD.

17, Bloomsbury Square, W.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Annalen der Chemie und Pharmacie, March, 1871.

This number contains the following original papers and memoirs:—

Products obtained by the Distillation of a Mixture of Butyrate and Acetate of Lime.—Dr. F. Grimm.—This very lengthy essay treats on—Propyl-methyl-keton—

$$\left\{\begin{matrix} C_3H_7 \\ CO \\ CH_3 \end{matrix}\right.$$

iso-amyl-alcohol; pinakon, $C_{10}H_{22}O_2$; ethyl-methyl-keton—

$$\left\{\begin{matrix} C_2H_5 \\ CO \\ CH_3 \end{matrix}\right.$$

dimethyl-keton and dipropyl-keton.

Fatty Acids contained in the Fusel Oil from Hungarian Wine, and on some Derivatives of Caprinic Acid.—Dr. F.

Grimm.—The subjects treated of in this exhaustive essay are—Caprinate of methyl—

$$\left.\begin{matrix}C_{10}H_{19}O\\CH_3\end{matrix}\right\}O;$$

caprinate of amyl—

$$\left.\begin{matrix}C_{10}H_{19}O\\C_5H_{11}\end{matrix}\right\}O;$$

caprinon—

$$\left\{\begin{matrix}C_9H_{19}\\CO\\C_9H_{19}\end{matrix}\right.$$

caprinyl chloride—

$$\left.\begin{matrix}C_{10}H_{19}O\\Cl\end{matrix}\right\}$$

caprinic acid anhydride.

Synthesis of the Oil of Rue.—Dr. E. von Gorup-Besanez and Dr. F. Grimm.—After referring to the researches of Drs. Geisecke, Fittig, and Strecker, bearing upon the constitution of the essential oil of rue (*Ruta graveolens*), as consisting of a mixture of ketons—viz., nonyl-methyl-keton, or caprinyl-methyluret, the authors describe, at great length, the experiments made by them for producing, synthetically, the oil alluded to by treating the fractional distillation products from a mixture of chemically pure caprinate and acetate of lime, so as to obtain caprinyl-methyluret, which agreed, in all properties, with that found in natural oil of rue.

Contribution to our Knowledge of Cholic Acid.—Dr. E. von Gorup-Besanez.—This paper is divided into the following sections:—Action of phosphoric chloride upon cholic acid, $C_{24}H_{40}O_5$; action of fusing caustic potassa upon cholic acid.

Advantageous Mode of Preparing Glycoholic Acid.—Dr. E. von Gorup-Besanez.—Fresh ox-gall is evaporated to dryness on a water-bath, exhausted with alcohol at 90 per cent, the alcohol removed by distillation, the residue treated with milk of lime, next gently heated, filtered, the filtrate treated with dilute sulphuric acid, avoiding excess. The glycoholic acid is deposited after a few hours' rest, and purified, first by filtration, pressing between folds of blotting paper, and re-dissolution in lime-water and re-precipitation by means of sulphuric acid.

Extraordinarily Large Quantity of Clay contained in a Human Lung.—Dr. E. von Gorup-Besanez.—This paper gives an account of a pathologico-chemical fact. The lungs of a person who had during lifetime worked in a factory, and been there exposed to the inhalation of mineral dust, were found to contain, in 1000 parts, no less than 19·91 parts of mixed sand, clay, and silica, giving, for the entire weight of the lungs, 1·5 kilos. 29·86 grms.

Caution.—Dr. E. von Gorup-Besanez.—This short paper gives an account of the effects of the explosion of only 10 drops of nitroglycerine, which, by one of the pupils of the author, in his laboratory, were put into a small cast-iron saucepan, and heated with a Bunsen gas-flame. The effect of the explosion was that the forty-six panes of glass of the windows of the laboratory were smashed to atoms, the saucepan was hurled through a brick wall, the stout iron stand on which the vessel had been placed was partly split, partly spirally twisted, and the tube of the Bunsen burner was split and flattened outwards. Fortunately, none of the three persons present in the laboratory at the time were hurt. The author takes the opportunity of referring to a communication Dr. E. Kopp, bearing upon the conditions under which nitroglycerine explodes or burns off quietly. When nitroglycerine is caused to fall drop by drop on a thoroughly red-hot iron plate, it burns off as gunpowder would do under the same conditions; but if the iron is not red-hot, but yet hot enough to cause the nitroglycerine to boil suddenly, an explosion takes place (*Comptes Rendus*, vol. lxiii., p. 189).

Zinc-Calcium Salt of the Ethylen-Lactic Acid as a means to obtain that Acid in Pure State.—Dr. W. Heintz.—This essay and the two following, by the same author, do not admit of any useful abstraction, notwithstanding their intrinsic merits.

Products of the Decomposition of Ethyliden-Chlorpropionic Acid and Ethylen-Iodpropionic Acid when Boiled with Milk of Lime.

Nature of the Lactic Acid of Meat—Muscular Tissue.

Action of Salts on Alcohol.—Dr. K. Kraut.—This paper contains the following sections:—Action of acetate of zinc upon alcohol; action of valerianate of zinc upon alcohol; action of formiate of zinc upon alcohol; action of the acetates of ammonia, soda, magnesia, protoxide of mercury, and oxide of silver upon alcohol.

Naphthyl-Purpuric Acid and the Derivatives thereof.—Dr. E. von Sommaruga.—This monograph, filled with a great number of lengthy and complex formulæ, is divided into the following chapters:—Salts of naphthyl-purpuric acid; products of the decomposition of naphthyl-purpuric acid; oxidation by means of nitric acid; action of fusing caustic alkali; indophan.

Description of an Apparatus suited to Exhibit the Liquefaction of Dry Ammoniacal Gas in Lecture-Rooms.—Dr. F. C. G. Müller.—Illustrated with a woodcut.

Synthesis of Coniine.—Dr. H. Schiff.—This exhaustive monograph does not admit of any useful abstraction, since it would require the reproduction of a series of very lengthy and complex formulæ.

The Titanic Acid obtained by Fusion with Phosphor-Salt in the Blowpipe-Flame is not Anatase.—Dr. A. Knop.—This paper mainly contains the description of the results of some blowpipe experiments made with the view to prove that the substance first obtained by Professor G. Rose while fusing titanic acid with phosphor salt, is not anatase (octahedrite of Dana's "System of Mineralogy," 5th edition, p. 161), but is simply phosphorate of titanic acid, $3TiO_2+PO_5$. In 100 parts—$3TiO_2$, 63·4; PO_5, 36·6.

New Solvent for Indigotine.—Dr. A. A. de Aguiar and Dr. A Bayer.—The solvent here alluded to is aniline, as obtained by the destructive distillation of indigo, and applied by the authors to obtain from commercial indigo the indigotine in pure state.

Bromated Derivatives of Acetic Acid Anhydride.—Dr. H. Gal.

Polytechnisches Journal von Dingler, first number for March, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Caloric Studies on the Cupola Furnaces Used in Iron Foundries.—Dr. C. F. Diirre.—This lengthy algebraico-physical monograph is, notwithstanding its great practical value, not well suited for any useful abstraction.

Preparation for Obtaining Decorative Colours on Metals.—Dr. Puscher.—The author employs for this purpose a solution of hyposulphite of lead in hyposulphite of soda, the latter in the proportion of 3 parts, by weight, of dry salt to 1 part of the acetate of lead, the quantity of water used for making the solution being about sixteen times the weight of the first-named salt. The clear solution of the salts deposits, when heated to about 100°, a thin layer of sulphuret of lead upon any metal—brass, zinc, copper—placed in the solution, and thereby produces a beautiful display of various colours on these objects.

Analysis of a so-called Native Meerschaum from New South Wales.—M. J. Stingl.—Sp. gr., 1·899. 100 parts of this mineral contain—Silica, 89·46; peroxide of iron, 0·45; alumina, 1·43; magnesia, 0·85; soda, 0·29; water driven off at 100°, 3·95; water driven off at red heat, 3·18; carbonaceous matter, 0·36. Since the silica is contained in this substance in such a state as to be nearly all soluble in caustic potassa solution of 1·35 sp. gr., this mineral might be applied as a raw material for making a soluble silicate; but the author observes that the boiling of this mineral with a concentrated solution of caustic soda only dissolved 19·2 per cent of the silica present. The term meerschaum is quite a misnomer for this mineral.

Action of Phosphorus upon Aniline.—M. A. Stiassny.—When phosphorus and aniline are heated with water, aniline red is formed, the aniline being oxidised by the decomposition of the water in the presence of phosphorus. When aniline, boiling at 185°, was heated with phosphorus, only a cherry-red colouration ensued; but if the same reaction were tried with an aniline boiling at a higher temperature, a brownish red colour was produced.

Conversion of Yellow Phosphorus into the Red Amorphous Modification thereof.—M. A. Stiassny.—The experiment here described is mainly the combustion of phosphorus under a bell-jar, when at the same time a small vessel is placed under the jar containing a solution of bichromate of potassa. At first, the combustion of the phosphorus proceeds as usual; but, when the quantity of air present has become too small to admit of the formation of phosphoric acid, phosphorous acid is generated, and this, reacting upon the chromate of potassa, reduces it partly to chromic oxide, while the phosphorous acid is thereby converted into phosphoric acid. This reaction is accompanied by the evolution of green-coloured vapours, while the non-consumed yellow phosphorus is converted into the red-coloured allotropic modification thereof.

Second number for March, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

New Method for Testing Malleable Metals and Alloys, and Description of the Apparatus to be Applied for that purpose.—Dr. G. Bischof.—This lengthy and valuable essay could only be well understood by the reproduction of a series of engravings illustrating the apparatus. The method is based on mechanical principles.

Manufacture of Bessemer Steel at Séraing Societé Anonyme de John Cockerill, près Liège Belgique, and on the Quality of the Steel as Applied in Various Ways.—Dr. C. F. Dürre.—A valuable contribution to the literature on Bessemer steel, but far too lengthy to admit of further notice here.

Analysis of a Sample of East Indian Tinkal (Pounxa).—Dr. H. Vohl.—This mineral was formerly the chief source of borax in Europe, when tinkal was rather largely imported from India. 100 parts of the mineral contain—Boracic acid, 36·8881; soda, 16·4771; silica, 0·0545; sulphuric acid, 0·2201; chlorine, 0·1681; peroxide of iron, 0·0068; alumina, 0·0013; protoxide of manganese, a trace; lime, 0·2415; magnesia, 0·1917; potassa, 0·0132; carbonic acid, a trace; water, 44·6451; sand and insoluble matter, 0·7775;—total, 99·6850. The mineral contains about 54 per cent of anhydrous borax. The author did not find any fatty or soap-like matter, nor any organic substance, in this specimen.

Bayerisches Industrie und Gewerbe Blatt, February, 1871.

This number contains the following original matter bearing upon chemistry and allied sciences:—

Varnish to Protect Polished Metals from Rusting.—Dr. C. Puscher.—The author recommends the use of a solution of paraffin (1 part, by weight, in 3 parts of petroleum) as a varnish which may be usefully applied to polished metals, especially as, after having brushed this liquid over the surface of the metals, they may be gently wiped clean with a soft piece of flannel, so as to leave only a very thin film of the varnish, yet sufficient for the protection of the polish.

Mixture for Producing so-called Pharaoh's Serpents which are not attended with Injurious Fumes.—Dr. C. Puscher.—Mix intimately together 2 parts of bichromate of potassa, 1 part of nitrate of potassa, and 3 parts of white sugar. This mixture should be pressed in paper or tinfoil cones, and, if intended to be kept for any length of time, the paper should be varnished over with sandarac varnish. A small quantity of balsam of Peru may be added to perfume the mixture, so as to cause its combustion to be attended with a pleasant odour. The greenish coloured very porous mass, which assumes the serpent shape, is a mixture of carbonate of potassa, oxide of chromium, carbon, and a small quantity of neutral chromate of potassa. The author states that this mass is an excellent substance for polishing all kinds of metals, and may be, moreover, usefully employed as an absorbent for moisture, instead of chloride of calcium, since this mass, without becoming pasty, absorbs, in twenty-four hours, about 20 per cent of moisture. The mixture above specified should be kept in a dark place.

Coating Brass with Copper.—Dr. C. Puscher.—Dissolve 10 parts, by weight, of sulphate of copper, and 5 of sal-ammoniac, in 150 parts, by weight, of water. Place the brass, well cleaned and free from fatty matter on its surface, into this mixture, leave it in it for a minute, let the excess of liquid drain off first, and heat the metal next over a charcoal fire, until the evolution of ammoniacal vapours ceases and the coppery film appears perfect. Wash with cold water, and dry. The coating of copper adheres firmly.

Journal für Praktische Chemie, No. 4, 1871.

This number contains the following original papers and memoirs:—

Periodides of the Alkaloids.—Dr. S. M. Jörgensen.—This paper is the second instalment of a very exhaustive monograph on this subject, and contains the following sections:—Methyl-chinin-triiodide, $C_{20}H_{24}N_2O_2,CH_3,I_3$; ethyl-chinin-triiodide, $C_{20}H_{24}N_2O_2,C_2H_5,I_3$; cinchonin-triiodide, $C_{20}H_{24}N_2O,H_2,I_2,H_2O$; methyl-cinchonin-triiodide, $C_{20}H_{24}N_2O,CH_3,I_3$; ethyl-cinchonin-triiodide, $C_{20}H_{24}N_2O,C_2H_5,I_3$; methyl-chinidin-triiodide, $C_{20}H_{24}N_2O_2,CH_3,I_3$; methyl-cinchonidin-triiodide; strychnin-triiodide, $C_{21}H_{22}N_2O_2HI_3$; methyl-strychnin-triiodide, $C_{21}H_{22}N_2O_2,CH_3,I_3$; ethyl-strychnin-triiodide; bromethyl-strychnin-triiodide, $C_{21}H_{22}N_2O_2,C_2H_4Br,I_3$; amyl-strychnin-triiodide; amyl-strychnin-pentaiodide; brucin-triiodide; brucin-diiodide; methyl-brucin-triiodide; methyl-brucin-pentaiodide; ethyl-brucin-triiodide; ethyl-brucin-pentaiodide; amyl-brucin compounds: amyl-brucin-triiodide; amyl-brucin-hexaiodide; allyl-brucin compounds; allyl-brucin-triiodide; allyl-brucin-pentaiodide; igasurine.

Behaviour of the Lithia-Containing Minerals with the Spectroscope; and on the Detection of Thallium in the Sphalerite found at Geroldseck, in Breisgau (a Province of the Grand Duchy of Baden).—Dr. von Kobell.—This paper gives an account of the testing of various minerals containing lithia with the spectroscope. The author puts the pulverised minerals on a piece of platinum foil formed like a channel, perforated with small holes, and held by means of a pair of platinum forceps. The author observes that, unless the mineral to be tested for lithia is previously well moistened with hydrochloric acid, the detection of lithia may fail, since only the spectrum of the flame tinged by chloride of lithium exhibits the characteristic line. Several minerals were also tested for thallium, and more especially some zinc ores (sphalerite is a kind of zinc blende). Most of these minerals gave a negative result; but the sphalerite from Geroldseck, and a similar mineral from Herbesthal (a small Prussian village, close to the Belgian frontier), gave very evident indications of the presence of thallium.

Some New Derivatives from Albumen.—M. O. Loew.—This paper treats on some substances obtained from albumen by treating it (with avoidance of heating) with a mixture of fuming nitric and concentrated sulphuric acids. One of the bodies thereby obtained is a yellow-coloured powder, insoluble in water, alcohol, and dilute acids, slightly bitter tasted, soluble in dilute alkalies, and precipitable therefrom without alteration. This body is hexanitro-albumen-sulpho acid—

$$C_{72}\left\{\begin{matrix}H_{101}\\(NO_2)6\\SO_3OH\end{matrix}\right\}N_{18}SO_{22}.$$

The other substances described at length are—Hexamido-albumen-sulpho acid—

$$C_{72}\left\{\begin{matrix}H_{101}\\(NH_2)6\\SO_3OH\end{matrix}\right\}N_{18}SO_{22};$$

albumen-sulpho acid—

$$C_{72}\left\{\begin{matrix}H_{107}\\SO_3OH\end{matrix}\right\}N_{18}SO_{22}$$

Contribution to our Knowledge of the Geminated (Gepaarten) Compounds of the Pentatomic Nitrogen.—M. C. W. Blomstrand.—The first instalment of a lengthy essay on this subject, which, although valuable in a scientific point of view, is not well suited for abstraction.

Declaration by Professor J. von Liebig.—This eminent *savant* states that several articles have been sold and manufactured, among others by M. J. P. Liebe, apothecary at Dresden, under the title of Liebig's unfermented extract of malt, Liebig's extract of malt with iron, iodine, quinine, iodide of iron, &c.; Liebig's condensed milk; and Liebe-Liebig's food for infants. Professor von Liebig desires it to be known that he never gave his consent to the use of his name in any of these articles, nor does he know anything about their real value, his name having been made use of without his consent and entirely against his will. The only dietetic preparation to which the Professor's name is attached with his full knowledge is the extract of meat prepared at Fray-Bentos, and the strict condition has been imposed upon the Company that no extract of meat shall be delivered to the trade unless it has been previously tested and approved of by Dr. M. von Pettenkofer.

NOTES AND QUERIES.

Cellulose.—Would any of your readers kindly inform me of any reliable process for determining the amount of woody fibre contained in hay, straw, esparto grass, &c.?—PAPYRUS.

Cryolite.—Can any of your chemical correspondents kindly inform me, through the medium of the CHEMICAL NEWS, who are manufacturers of aluminate of soda made from cryolite.—ALUMINA.

Analysis of Iron Ores.—I should be glad to know of a good method of estimating organic matter in iron ores. Also whether the iron in the residue, insoluble in HCl, is always in the form of persalt. —L. PETERS.

Phlogiston.—A correspondent sends us the following short report of a lecture at the Royal Institution, April 28th, 1871.

The gist of a lecture you here may now see as
A point that no soul will insist on:—
"We can square ancient thoughts with modern ideas,
If we 'Energy' read for 'Phlogiston!'"

Manipulating India-Rubber.—Will any of your readers kindly inform me where I can find any simple process (suitable for amateurs —*boys*), by which india-rubber can be softened sufficiently to be pressed into a mould, and retain the shape but recover its elasticity. Also, if there is any way of colouring, either india-rubber in its ordinary state, or the white solution of it used by manufacturers. The colour wanted is blue, or red, or flesh-colour.—F. BANKES.

Dr. Dingler's Compressed Leather.—Having tried Dr. Dingler's method of rendering leather cuttings plastic, and failed in so doing, I would kindly ask that gentleman, through the medium of the CHEMICAL NEWS, if he will be kind enough to give the full and exact manipulation—how to accomplish the method of rendering leather cuttings soft and plastic, as recommended in your journal of January last; by so doing he will confer a favour to many of your readers as well as myself.—A LEATHER WORKER.

Aluminium for Batteries.—I have lately seen a proposal to use aluminium foil instead of platinum in nitric acid batteries. I am, however, inclined to think that the change would be disadvantageous, and should be glad if you could find room for the following account of an experiment I made to test its utility. I took a small piece of foil and put it into some acid which had been used for some time in the battery with a solution of salt in the outer cell. In a few hours it was eaten through. Hence I conclude that the aluminium would not do when salt is used, and I should suppose that it would also be necessary to use nitric acid free from hydrochloric acid, which would add considerably to the expense of working. —T. H. WALLER.

MEETINGS FOR THE WEEK.

MONDAY, 8th.—Royal Geographical, 8.
—— Royal Institution, 2. General Monthly Meeting.
TUESDAY, 9th.—Ethnological, 8.
—— Civil Engineers, 8.
—— Photographic, 8.
—— Royal Institution, 3. Charles Brooke, M.A., F.R.S., "On Force and Energy."
WEDNESDAY, 10th.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 11th.—Royal, 8.30.
—— Royal Society Club, 6.
—— Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
FRIDAY, 12th.—Royal Institution, 9. Col. Jervois, R.E., C.B., "On the Defence of the United Kingdom."
—— Quekett Microscopical Club, 8.
—— Astronomical, 8.
SATURDAY, 13th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."
—— Quekett Microscopical Club. Excursion to Chislehurst; to meet at Charing Cross Station at 2 p.m.

TO CORRESPONDENTS.

A. N. P.—Names of works on the subject have often appeared in our Correspondence column.

R. Warington.—The communication arrived too late for insertion in our last issue.

W. R.—Consult our advertising columns.

A. E. Davies, Ph.D.—Received with thanks.

J. P.—Our advertisement columns would be the proper place for your communication.

W. Rowley.—Reimann's "Handbook of Aniline." Our publisher will send it to you post free on receipt of 10s. 10d.

J. Jones.—The journal has been received, for which accept our thanks.

Just published, 8vo., price 2s. 6d.,

ANALYTICAL TABLES
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STUDENTS OF PRACTICAL CHEMISTRY.

By J. CAMPBELL BROWN, D.Sc. (Lond), F.C.S.

London: J. and A. Churchill, New Burlington-street.
Liverpool: Adam Holden, 48, Church Street.

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Select Methods in Chemical Analysis, chiefly Inorganic. By WILLIAM CROOKES, F.R.S., &c., Editor of the CHEMICAL NEWS and of the *Quarterly Journal of Science.*

London: Longmans, Green, and Co., Paternoster Row.

Just published, price One shilling,

A Concise View of the Law connected with Letters Patent for Inventions. By JAMES JOHNSON, of the Middle Temple, Barrister-at-Law, and J. HENRY JOHNSON, Assoc. Inst. C.E., Solicitor and Patent Agent, Lincoln's Inn Fields and Glasgow. Authors of the "Patentees' Manual."

London: Longmans, Green and Co., Paternoster Row.

Royal 8vo., pp. 388, price 7s. 6d. Third Edition.

The Patentee's Manual; being a Treatise on the Law and Practice of Letters Patent, especially intended for the use of Patentees and Inventors. By JAMES JOHNSON, Barrister-at-Law; and J HENRY JOHNSON, Assoc. Inst. C.E., Solicitor and Patent Agent.

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London: Longmans, Green, and Co.

Just published, demy 8vo., 6s., by post 6s. 6d. (vol. i.),

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THE CHEMICAL NEWS.

VOL. XXIII. No. 598.

RESEARCH ON A NEW GROUP OF COLLOID BODIES, CONTAINING MERCURY, AND CERTAIN MEMBERS OF THE SERIES OF FATTY KETONES.*

By J EMERSON REYNOLDS, M.R.C.P. Ed.,
Vice-President R.G.S.J., Keeper of the Mineral Department, and Analyst to the Royal Dublin Society.

(1). *Colloid Body Obtained by Uniting Acetone with Mercuric Oxide.*—When solution of mercuric chloride is slowly added to a mixture of acetone with dilute aqueous solution of potassium hydrate, the murcuric oxide first precipitated is dissolved, with the production of a clear colourless liquid. The addition of the mercurial solution can be continued until a white precipitate makes its appearance, the alkali being still in excess. If the solution be filtered at this point, an apparently opalescent, yellowish-coloured liquid is obtained. If one portion of this alkaline solution be boiled for a few minutes, a thick gelatinous mass suddenly separates, and further ebullition is rendered difficult, if not impossible. Another portion of the liquid, when treated with an acid in slight excess, gelatinises, and if the original solution be moderately strong, the vessel in which the experiment is made may be inverted without risk of spilling its contents. Finally, if some of the mercuric solution be exposed over sulphuric acid *in vacuo*, it leaves on partial evaporation a gelatinous mass, on the surface of which latter crystals of potassium chloride soon make their appearance. When the desiccation is complete, a yellowish resinoid body is obtained, together with a large quantity of very beautiful acicular crystals of the chloride, and a certain amount of potassic carbonate.

Preliminary experiments similar to the foregoing were sufficient to indicate that the chief compound produced in the reaction above referred to might be regarded as a colloid body. I therefore took advantage of the late Professor Graham's beautiful dialytic method for effecting its purification from crystalloids, and have met with complete success.

Preparation of Colloid Liquid.—40 grms. of pure mercuric chloride are to be dissolved in about 500 c.c. of hot water and the solution then allowed to cool, even though crystals of the salt separate. 29 grms. of potassium hydrate are next dissolved in about 300 c.c. of water; 15—20 c.c. of acetone should now be placed in a capacious glass balloon, and diluted with 250 c.c. of water. The reaction is then to be managed as follows:—About 150 c.c. of the alkaline solution should be added to the aqueous acetone, and then 250 c.c. of the mercuric chloride gradually poured in. Re-solution of the mercuric oxide first thrown down proceeds slowly at the outset, if the mixture be not warmed. After a time the oxide quickly re-dissolves, if the contents of the balloon are briskly agitated. When the first half of the mercuric solution has been added, the remaining 150 c.c. of potassium hydrate are to be cautiously poured in and the residual mercuric chloride then mixed with the precautions already stated.

The solution prepared in the manner described is usually turbid, but can be easily filtered clear, from the small amount of mechanically suspended matter. The filtrate should next be placed on a large hoop dialyser, covered as usual with carefully prepared parchment paper, and the vessel floated on a considerable volume of distilled water. After two days' action the diffusate will be found to contain a large quantity of potassium chloride, some potassium hydrate, and but a very small amount of mercury. The process of diffusion is to be continued, the diffusate being replaced by pure water twice each day, until the liquid on which the dialyser floats no longer affords a cloud when treated with a solution of silver nitrate. The process may then be considered terminated, and the pure colloidal liquid obtained. The contents of the dialyser can be now removed, and should be free from all odour of acetone. A few drops, when evaporated to dryness on platinum foil and the residue ignited, should volatilise completely.

Analyses of the Anhydrous Compound.—I took a considerable volume of the very carefully prepared colloid liquid and divided it in two parts. One portion was very cautiously evaporated to dryness, and the resinoid residue very finely powdered and carefully dried. The second portion was precipitated by the addition of dilute acetic acid, and the gelatinous precipitate washed rapidly and completely with the aid of Bunsen's filter-pump, and the residue dried. The desiccation in each case was effected at first *in vacuo* over sulphuric acid, and finally on the water-bath. The compound easily bears a temperature of 100° C.

On analysing both products, I found that they were practically identical in composition. As the presence of the volatile metal introduced some difficulty in the determinations, it is necessary to describe the plan of analysis adopted.

The mercury was, in some cases, obtained in the metallic state by distillation with quicklime; but I much prefer to digest a weighed quantity of the compound in a sealed tube with dilute hydrochloric acid, and, after complete solution has taken place, to break the tube, precipitate the metal from the contents by sulphuretted hydrogen, and weigh the mercury in the usual way as sulphide. The results are very satisfactory.

The presence of a large proportion of mercury in the compound rendered the accurate determination of carbon and hydrogen somewhat difficult. At the outset of this investigation I arranged a very troublesome process of analysis, similar to that employed by Messrs. Frankland and Duppa in their analysis of mercuric ethide and its analogues. In all later combustions I have adopted the very simple and satisfactory plan of placing in the anterior part of the combustion-tube a layer of 15 centims. of any metal capable of easily amalgamating with mercury. Gold and silver foil answer the purpose well: no doubt tin foil might be used in the same way. It is scarcely necessary to add that the temperature of the anterior part of the combustion-tube containing the gold or silver was in each instance very carefully regulated.

Results were obtained which showed the composition of the body to be well represented by the formula—

$$[(CH_3)_2CO]_2Hg_3O_3.$$

Properties of the Colloid Body, Hydrated and Anhydrous.—Analogy would lead us to conclude that the collodial liquid obtained by dialysis is a hydrate of the body represented by the above formula; but since evaporation *in vacuo* is sufficient to remove the water completely, the hydrate can possess but little stability. Properly speaking, this hydrate is no doubt a true liquid, and as such is miscible with other liquids.

The reaction of this hydrate is neutral to test-papers.

When the aceto-mercuric hydrate contains 5 per cent of the anhydrous compound, it will, if quite pure, remain liquid for twelve or fourteen days, toward the end of this time becoming gradually less fluid, until the whole "sets" to a firm jelly. The same result may be bronght about in a few seconds by the addition to the perfectly neutral liquid of very minute quantities of any of the following substances:—Hydrochloric, acetic, nitric, sulphuric (incompletely), chromic, oxalic, tartaric, or citric acids; by potassium, sodium, ammonium, barium, and calcium hydrates; by calcium chloride, mercuric chloride, sodium acetate, and other neutral salts. Contact with certain in-

* Abstract of a paper read before the Royal Society, April 20th, 1871.

soluble powders, such as calcium carbonate, and even alumina, induces pectisation.

Elevation of temperature quickly determines the gelatination of the liquid. If containing 5 per cent of the ketone compound, a very firm jelly is produced on heating to 50° C. In one experiment, a quantity of the liquid was taken and some bright, carefully cleaned copper gauze introduced The liquid did not pectise, nor did any trace of mercury deposit on the copper, after standing for a day. The temperature of the whole was then raised to 50° C.; a transparent jelly was at once produced, of such strength that the vessel in which it was contained could be inverted without any risk of loss, This jelly, enclosing the bright copper gauze, has remained in my possession for eight months without giving the slightest indications of a disposition to change.

Small zoological specimens, when enclosed in the same way in a jelly of the mercuric ketone compound, were found to keep well when carefully cleansed before they were sealed up in the gelatinous envelope.

By evaporation, a liquid containing 8 per cent of the ketone compound was obtained, but it pectised in a few hours. A 2 per cent hydrate retained its liquidity for several months. When once a jelly has formed in any of these liquids, I have not succeeded completely in reconverting it to the liquid state by very cautious treatment with potassium hydrate, even when aided by diffusion.

When the colloid hydrate was treated with sulphuretted hydrogen, mercuric sulphide was produced. The liquid filtered from the sulphide yielded *acetone* on distillation. Digestion with dilute hydrochloric acid likewise effected the decomposition of the colloid body, mercuric chloride being produced and acetone liberated. Nitric and sulphuric acids, when dilute, did not decompose the compound with the same facility as hydrochloric acid. Treatment of the hydrosol with copper, zinc, or iron *at ordinary temperatures*, failed to effect the substitution of either metal for the mercury in the compound. Prolonged contact with each of the two last-mentioned metals caused pectisation, the metal subsequently becoming encrusted with a white substance. Heat produced the same result more rapidly.

When the anhydrous compound was cautiously heated, a quantity of acetone distilled over, and, as the temperature rose, empyreumatic products and mercury were evolved. When the heat was suddenly applied, much metallic mercury distilled over, and a minute quantity of a liquid, having the odour of mercuric methide, was produced, together with carbonic anhydride and other gaseous bodies not particularly examined.

Detection of Acetone in the "Methylated Spirit" of Commerce.—Since acetone is, according to my experience, invariably present in the wood-spirit of commerce, the reaction with mercuric oxide in presence of potassium hydrate, already described, becomes virtually a test for the presence of pyroxylic spirit in any mixture. The ordinary "methylated spirit" of commerce is such a mixture, and the acetone present in it can be detected with great facility in the following way:—Take 200 c.c. of the spirit and rapidly distil off 50 c.c.; dilute the distillate with an equal volume of water, and slightly warm with addition of a few c.c. of solution of potassium hydrate. On cautious addition of mercuric chloride, the oxide first thrown down is speedily re-dissolved: excess of the mercuric salt must be carefully avoided. The alkaline liquid should be filtered clear, much of the alcohol allowed to evaporate slowly, and the residue then divided in two portions. One part is to be violently boiled for a few minutes; a yellowish-white gelatinous precipitate will suddenly make its appearance, if the acetone compound be present. In the second portion, dilute acetic acid, when added in slight excess, should produce a bulky, white, gelatinous precipitate containing, when washed and completely dried, between 78 and 79 per cent of mercury. Finally, by means of the above test the admixture of "methylated spirit" with alcoholic solutions may be detected with facility. In all such cases, however, a specimen of a pure alcoholic solution should be tested at the same time as the suspected sample, distillation of considerable quantities of the liquids being resorted to in every instance.

(2). *Bodies containing Mercury and Higher Members of the Fatty Ketone Series.*—Experience has proved that several ketones of the fatty series are capable of uniting with mercuric oxide in the presence of alkali to form compounds analogous to that obtained with acetone. The higher ketones being insoluble in water though soluble in alcohol, it was found to be extremely difficult to prepare the colloidal hydrates or hydrosols of the mercuric compound.

In the case of butyrone, however, I have succeeded completely in obtaining a hydrosol.

The general reactions of the several solutions leave no doubt that the compound contained in each belongs to the group of colloid bodies and not to that of crystalloids.

The following results have been obtained:—

(*a*). *With Propione.*—The rectified products of the careful destructive distillation of barium propionate was dissolved in alcohol and mercuric chloride added; excess of strong aqueous solution of potassium hydrate was then poured in; on gently warming the mixture the mercuric oxide dissolved in great part. The liquid, filtered as clear as possible, was found to be rich in mercury, and when treated with excess of dilute acetic acid, gave a white gelatinous precipitate precisely analogous to that obtained under similar circumstances from the potassium di-acetomercurate.

The precipitate was found on analysis to contain 72·26 per cent of mercury; the formula requires 73·17 per cent. On treatment with hydrochloric acid, the precipitate afforded mercuric chloride and an oily liquid insoluble in water, possessing the odour of and characters attributed to propione.

(*b*). *With Butyrone.*—The rectified product of the destructive distillation of calcium butyrate, when dissolved in alcohol and treated with mercuric chloride and potassium hydrate, gave, on warming, a liquid similar to that obtained with propione. Like the latter, it afforded a white precipitate on treatment with excess of dilute acetic acid. The precipitate, when carefully washed and dried, contained 69·1 and 69·27 per cent of mercury; the formula $[(C_3H_7)_2CO]Hg_3O_3$ requiring 68·49 per cent. The freshly prepared precipitate, when digested with excess of hydrochloric acid, afforded mercuric chloride and a small quantity of a liquid insoluble in water and recognisable as butyrone.

The alkaline alcoholic solution of the butyrone mercuric compound was diluted with its own volume of water, then filtered and carefully warmed in order to slowly evaporate the alcohol as much as possible. When a considerable portion of the latter had been removed in this way, the clear residual liquid was placed on a dialyser, and the attempt made to diffuse away the crystalloids from the liquid. After treatment for five days, most of the chloride had diffused away, and a liquid was obtained which pectised on heating to near the boiling-point, and on the addition of a small qnantity of a mineral acid. The precipitate first formed by hydrochloric acid was easily redissolved on heating with excess of the reagent and the odour of the ketone developed. The attempt to convert the alcosol of the mercuric compound into the hydrosol had therefore been attended with success.

(*c*). *With Valerone.*—Obtained by purifying the product of the distillation of calcium valerate previously mixed with one-sixth of its weight of quicklime. When this was dissolved in alcohol and the solution was rendered alkaline by potassium hydrate and mercuric chloride dropped in, the mercuric oxide first precipitated was speedily re-dissolved, but from the solution no precipitate was thrown down on addition of an acid, previously mixed with alcohol. I have not obtained any compound from this alkaline liquid possessing distinctive properties. It

is not improbable that the valerone mercuric compound, if formed, is more easily decomposed by acids than the corresponding bodies obtained with other ketones; hence the difficulty of isolating it.

I may now be allowed to summarise the results of the investigation detailed in the foregoing pages. It has been shown:—

1. That certain fatty ketones can be made to unite directly with mercuric oxide.

2. That the resulting compounds afford a new group of colloid hydrates, analogous in properties to the silicic, aluminic, and other hydrates already made known by the researches of Professor Graham.

3. That the new hydrates may best be regarded as extremely feeble conjugate acids; the chief member of the group (that derivable from acetone) being probably tetrabasic and capable of affording very unstable salts.

4. That the generating reaction for these bodies may, when carefully controlled, be employed as a test for the presence of a ketone, especially for acetone in certain organic mixtures.

5. That the generating reaction for the di-keto-mercurates may, when carefully controlled, be employed as a test for the presence of a ketone—especially for acetone—in certain organic mixtures.

ON THE

INCREASE OF ELECTRICAL RESISTANCE

IN

CONDUCTORS WITH RISE OF TEMPERATURE,

AND ITS

APPLICATION TO THE MEASURE OF ORDINARY AND FURNACE TEMPERATURES;

ALSO ON A SIMPLE METHOD OF MEASURING ELECTRICAL RESISTANCES.*

By C. W. SIEMENS, F.R.S., D.C.L.

THE first part of this paper treats of the question of the ratio of increase of resistance in metallic conductors with increase of temperature.

The investigations of Arndtson, Dr. Werner Siemens, and Dr. Matthiessen, are limited to the range of temperatures between the freezing- and boiling-points of water, and do not comprise platinum, which is the most valuable metal for constructing pyrometric instruments.

Several series of observations are given on different metals, including platinum, copper, and iron, ranging from the freezing-point to 350° C.; another set of experiments being also given, extending the observations to 1000° C. These results are planned on a diagram, showing a ratio of increase which does not agree either with the former assumption of a uniform progression, or with Dr. Matthiessen's formula, except between the narrow limits of his actual observations, but which conforms itself to a parabolic ratio, modified by two other coefficients, representing linear expansion and an ultimate minimum resistance.

In assuming a dynamical law, according to which the electrical resistance of a conductor increases according to the velocity with which the atoms are moved by heat, a parabolic ratio of increase of resistance with increase of temperature follows; and in adding to this the coefficients just mentioned, the resistance r for any temperature is expressed by the general formulæ, $r=\alpha T^2+\beta T+\gamma$, which is found to agree very closely both with the experimental data at low temperatures, supplied by Dr. Matthiessen, and with the author's experimental results, ranging up to 1000° C. He admits, however, that further researches will be necessary to prove the applicability of the law of increase expressed by this formula to conductors generally.

* Abstract of a paper read before the Royal Society, April 25th, 1871.

In the second part of this paper it is shown that, in taking advantage of the circumstance that the electrical resistance of a metallic conductor increases with an increase of temperature, an instrument may be devised for measuring with great accuracy the temperature at distant or inaccessible places, including the interior of furnaces, where metallurgical or other smelting operations are carried on.

In measuring temperatures not exceeding 100° C. the instrument is so arranged that two similar coils are connected by a light cable containing three insulated wires. One of these coils, "the thermometer-coil," being carefully protected against moisture, may be lowered into the sea, or buried in the ground, or fixed at any elevated or inaccessible place whose temperature has to be recorded from time to time; while the other, or "comparison-coil," is plunged into a test-bath, whose temperature is raised or lowered by the addition of hot or cold water, or of refrigerated solutions, until an electrical balance is established between the resistances of the two coils, as indicated by a galvanoscope, or by a differential voltameter, described in the second paper, which balance implies an identity of temperature at the two coils. The temperature of the test-solution is thereupon measured by means of a delicate mercury thermometer, which at the same time tells the temperature at the distant place.

By another arrangement the comparison-coil is dispensed with, and the resistance of the thermometer-coil, which is a known quantity at zero temperature, is measured by a differential voltameter, which forms the subject of the second paper; and the temperature corresponding to the indications of the instrument is found in a table prepared for this purpose, in order to save all calculation.

In measuring furnace temperatures the platinum-wire constituting the pyrometer is wound upon a small cylinder of porcelain contained in a closed tube of iron or platinum, which is exposed to the heat to be measured. If the heat does not exceed a full red heat, or, say, 1000° C., the protected wire may be left permanently in the stove or furnace, whose temperature has to be recorded from time to time; but in measuring temperatures exceeding 1000° C., the tube is only exposed during a measured interval of, say, three minutes, to the heat, which time suffices for the thin protecting casing and the wire immediately exposed to its heated sides, to acquire within a determinable limit the temperature to be measured, but is not sufficient to soften the porcelain cylinder upon which the wire is wound. In this way temperatures exceeding the welding-point of iron, and approaching the melting-point of platinum, can be measured by the same instrument by which slight variations at ordinary temperatures are told. A thermometric scale is thus obtained embracing without a break the entire range.

The leading wires between the thermometric coil and measuring instrument, which may be, under certain circumstances, several miles in length, would exercise a considerable disturbing influence if this were not eliminated by means of the third leading wire before mentioned, which is common to both branches of the measuring instrument.

Another source of error in the electrical pyrometer would arise through the porcelain cylinder upon which the wire is wound becoming conductive at very elevated temperatures; but it is shown that the error arising through this source is not of serious import.

The third part of the paper is descriptive of an instrument for measuring electrical resistance without the aid of a magnetic needle or of resistance scales. It consists of two voltameter tubes fixed upon graduated scales, which are so connected that the current of a battery is divided between them, with one branch including a known and permanent resistance, and the unknown resistance to be measured. The resistance and polarisation being equal, and the battery being common to both circuits, these unstable elements are eliminated by balancing them from the circulation, and an expression is found for the un-

known resistance X in the known resistances C and γ of the voltameter, including the connecting wires and the volumes V and V' of gases evolved in an arbitrary space of time within the tubes, viz.:—

$$X = \frac{V}{V'}(C+\gamma)-\gamma. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Changes of atmospheric pressure affect both sides equally, and do not therefore influence the results; but a reading of the atmospheric pressure is obtained at both sides by lowering the little supply reservoir with dilute acid to the level indicated in the corresponding tube. The upper ends of the voltameter tubes are closed by small weighted levers provided with cushions of india-rubber. But after each observation these levers are raised, and the supply reservoirs moved so as to cause the escape of the gases until the liquid within the tubes is again brought up to the zero line of the scale, when the instrument is ready for another observation. A series of measurements are given of resistances varying from 1 to 10,000 units, showing that the results agree within 1 per cent with the independent measurements obtained of the same resistances by the Wheatstone method.

The advantages claimed for the proposed instrument are, that it is not influenced by magnetic disturbances, or the ship's motion if used at sea; that it can be used by persons not familiar with electrical testing; and that it is extremely simple and easily procured.

ON THE

CAUSES OF HIGH AND LOW ESTIMATIONS OF SOLUBLE PHOSPHATES.

By ARTHUR E. DAVIES, Ph.D., F.C.S., &c.

IN answer to Mr. Little's appeal in the last number of the CHEMICAL NEWS, will you permit me to make the few following observations?—That gentleman, after referring to the wide difference in the percentage of soluble phosphate returned by different analysts from the same sample, and the importance of this difference in a commercial point, says: "When we ask for some explanation, you will observe the reply is either nothing, or that there is some difference in the process of analysis." In order to give a fuller and more complete explanation than the above, I have hastily put together the following observations, for which I trust you will be able to allow me space in the next number of your journal:—

The material known in commerce as superphosphate is prepared by certain chemical processes from bones, either raw or reduced to ash by burning, coprolites, apatite, &c. These materials all agree in containing a certain proportion of phosphoric acid in combination with lime in the form of tricalcic phosphate, or, as it is more commonly called, bone-earth or insoluble phosphate of lime. The object of the treatment to which these materials are submitted is not to increase the amount of fertilising matter which they contain, but, by changing it into a more soluble form, to render it more easily and rapidly available for the purposes of the plant. This change is effected by acting upon the bone or other phosphatic material with oil of vitriol. When this is brought in contact with the tricalcic or insoluble phosphate, the latter yields up to the former two of its three equivalents of lime, sulphate of lime or gypsum being produced, whilst the place of the lime is supplied by two equivalents of water, the product being the monocalcic or soluble phosphate—

$$3CaO.PO_5+2HOSO_3=2CaOSO_3+2HO.CaO.PO_5.$$

It is the great difference in the results obtained by different chemists in estimating these soluble phosphates which has given rise to the distinction of high and low analysts. The source of these differences lies, not in any manipulative error on the part of the analyst, but in imperfections in the process by which the analyses are made. These processes are either those by which the phosphate is estimated by direct precipitation, as tricalcic phosphate, or those by which the phosphates are decomposed, and their phosphoric acid estimated separately. When the first of these plans is followed a suitable quantity of the sample, accurately weighed, is ground in a small mortar with a little cold water, the undissolved matter allowed to settle, and the clear, or almost clear, supernatant liquid poured on a filter. This operation is repeated three or four times, by which the whole of the monocalcic or soluble phosphate should be dissolved and pass into the filtrate. The undissolved residue is then transferred to a beaker, and boiled with water two or three times, the liquid, after each boiling, being poured through the filter. The object of this operation is to extract sufficient sulphate of lime to re-convert the monocalcic into tricalcic phosphate. The insoluble residue is dissolved in hydrochloric acid, the sand being of course removed by filtration. We thus obtain two solutions, the water containing the soluble phosphate, and the acid the insoluble. It is with the former of these alone that we have at present to deal. If sufficient sulphate of lime has been dissolved to completely re-convert the monocalcic into tricalcic phosphate, these are precipitated from the water solution by simply adding a slight excess of ammonia. The monocalcic phosphate then takes back two equivalents of lime, and is re-converted into tricalcic phosphate, in which state it falls as an insoluble precipitate. If however, sufficient lime has not been dissolved, as sometimes happens, then chloride of calcium must be added in addition to ammonia, and some chemists always add the salt without first ascertaining whether or not the solution already contains a sufficient quantity of lime. It is to errors introduced at this part of the process that the inaccurate results of the so-called high analysts are due. It has just been shown that, for the complete precipitation of the soluble phosphate, by ammonia, a certain quantity of lime is required; and as it is impossible to obtain exactly the required quantity, we may consider that it is absolutely necessary that the liquid should contain an excess of lime. Should the ammonia employed as a precipitant contain—as it frequently does—carbonic acid, more or less lime will be thrown down as carbonate, and introduced into the results of the analysis as phosphate. This, however, is not the most common cause of error, and it is one which is entirely avoided if the ammonia is free from carbonate. When the solution contains an appreciable excess of lime, the spongy precipitate of phosphate thrown down by ammonia will retain a certain quantity of lime mechanically, which it is quite impossible to remove by any practical amount of washing. It may, however, be got rid of by re-dissolving the well-washed precipitate in hydrochloric acid, and re-precipitating with ammonia, when the phosphate of lime will be thrown down in a pure state. Unfortunately, however, the practice of chemists with regard to re-dissolving, differs. Some (the low analysts) always re-dissolve, and their results are, consequently accurate. Others (the high analysts) never do so, and they necessarily weigh and calculate as phosphate a quantity of lime existing in a different and valueless form. The only truly accurate and reliable processes are those in which the phosphoric acid is estimated apart from the lime. For these the solutions are prepared in the way already described; but, instead of estimating the phosphates by direct precipitation, they are decomposed, and the phosphoric acid separated and estimated by one of the well-known processes. In my own laboratory the plan adopted is to precipitate with an excess of ammonia, re-dissolve the precipitated phosphate in acetic acid, and separate the lime as oxalate. In the filtrate from the oxalate of lime the phosphoric acid is estimated as phosphate of magnesia. In this manner the amount of phosphoric acid may be determined with almost absolute accuracy, and from it the amount of soluble phosphate is readily calculated. Were some such process adopted by all chemists

we should soon cease to hear of the great differences in results now so frequently obtained from the same sample by two chemists of equal and acknowledged competence.

ARSENIC IN PYRITES AND VARIOUS PRODUCTS.*

By H. A. SMITH.

THE difference existing between the amount of arsenic in pyrites in published analyses, and that found in practical working, led the author to make the following series of experiments, the results of which are arranged in three tables.

Table I., Part I., gives the analysis of various specimens of pyrites; these are extracted from Richardson and Watts's "Technology." In Part II., the author's analyses are given of a few specimens of the same species of ore.

Table II. gives the amount of arsenic in a certain kind of pyrites, in the sulphuric acid manufactured from it, and in the various products in the manufacture of which the sulphuric acid had been used; also the amount of arsenic in the chamber and flue deposits.

Table III. is calculated from Table II., giving the amount in a manner more useful for practical purposes.

TABLE I.

Pyrites.	Arsenic per cent.	Pyrites.	Number of analyses made.	Arsenic per cent.
Spanish	0·21 to 0·31	Spanish { Mason's.	10	1·7453
		Spanish { Tharsis.	10	1·6517
Belgian	Trace.	Belgian.	8	0·9437
Westphalian ..	Trace.	Westphalian.	8	1·8783
Norwegian ..	None.	Norwegian { Hard.	8	1·6490
		Norwegian { Soft.	8	1·7085

TABLE II.

Substance in which arsenic is found.	Number of Analyses.	Arsenic per cent.
Pyrites before burning	8	1·649
,, after ,, ...	4	0·465
Sulphuric acid	15	1·051
Deposit in flue leading from pyrites kiln to lead chamber	4	46·360
Deposit on bottom of lead chamber ..	5	1·857
Hydrochloric acid	8	0·691
Sulphate of soda	15	0·029
Soda waste	6	0·442
Carbonate of soda	12	—
Recovered sulphur (Mond's process) before purification began	4	0·700
Mond's process, latest methods	2	0·000

The pyrites used for analysis in Table II. was the hard Norwegian, and this, as may be seen in Table I., comes next in order in freedom from arsenic to the Belgian. The Belgian itself was put aside, owing to the fact that it made too much "smalls" in breaking for the kilns, which became an expense as well as inconvenience.

TABLE III.

	Tons As.
100 tons of hard Norwegian pyrites (Table I.) contain, before burning	1·649
Ditto, after burning	0·465
100 tons of hard Norwegian pyrites make 140·875 tons of H_2SO_4, containing	1·481
140·875 tons of sulphuric acid make 104·9 tons of HCl, containing	0·724
140·875 tons of sulphuric acid make 204·12 tons of Na_2SO_4, containing	[illegible]

This Table gives the amounts of arsenic on a practical scale, so that the total impurity may be seen at once.

We see, by this Table, how the arsenic persistently adheres to the products in the manufacture of which acid made from pyrites has been used, and how it becomes distributed through the acid and soda in various stages.

The arsenic also has an effect on the nitric acid supplied to the lead chamber, being converted from arsenious to arsenic acid, and thereby causing a slight loss of the nitric acid gas. In the deposit in the chamber (mentioned in Table II.) were found crystals of arsenic acid, as a proof of this result.

* Read before the Manchester Literary and Philosophical Society, April 4th, 1871.

ON THE

ELECTROMOTIVE AND ELECTROLYTIC PHENOMENA DEVELOPED BY GOLD AND PLATINA IN SOLUTION OF THE ALKALINE SULPHIDES AND SULPHURETTED HYDROGEN.*

By WILLIAM SKEY,
Analyst to the Geological Survey of New Zealand.

THE author shows that electric currents of considerable intensity are developed by either gold or platinum under the following circumstances:—

Two plates of gold (prepared chemically pure) are taken; one is placed in a cell charged with sea-water, and the other in a porous cell charged with sulphide of ammonium, which cell is partially immersed in the former. These plates are connected voltaically; a common galvanometer inserted in the circuit will then have its needle vigorously deflected—and the direction of this indicates the electric current is from the gold in the porous cell to that in the outer cell.

Electric currents of equal strength were also developed by charging both cells with sea-water, or solution of potash or ammonia, and administering sulphuretted hydrogen to either cell.

By charging one of the cells with potash and ammonia, and the other with sea-water, a current of electricity was also produced, but of far feebler intensity than those above cited, and which might be owing to traces of sulphur in these alkaline solutions.

The currents obtained by either of these metals in alkaline sulphides had sufficient intensity to decompose certain metallic solutions—for instance, those of copper, gold, and silver—the metal being deposited in a compact and regular form.

To avoid any errors which might be caused by films of air, &c., adhering to the metallic plates, and so getting contact with the solutions, these plates were always, prior to their immersion in these solutions, raised to a red heat, and while in this state plunged into water or the saline solutions about to be used, which liquids themselves had been previously boiled to expel the gases dissolved in them.

The author further found that both gold and platinum are positive to iron in solutions of alkaline sulphides, and he gives a list of various metals, in the order of their negativeness relatively to each other, in such solutions, of which the following is a copy (the order is from negative to positive):—

Carbon.	Mercury.
Iron.	Lead.
Gold.	Tin.
Platinum.	Copper.
Silver.	Zinc.

To obtain these results, it is necessary to avoid the presence of caustic alkalies in these solutions. The capability of gold and platinum to generate electric

* Abstract of a paper read before the Wellington Philosophical Society, January 29th, 1871.

currents under these circumstances—currents of such intensity as to decompose the metallic solutions cited—the author takes to be conclusive of the correctness of his opinion that the absorption of sulphur by these metals (as described in a former paper of his) is a true chemical act.

In conclusion, the author alludes to the announcement, by Professor Becquerel, in a series of papers, of a certain electromotive power of gold and platinum in pure water, also in neutral and saline solutions, abstracts of which announcements, as given in certain numbers of the CHEMICAL NEWS, were laid upon the table for reference of members, and from which the author considers his own researches are quite distinct, in method and results, to to those entered upon by Professor Becquerel, and for the following reasons:—(1) Professor Becquerel describes these electric phenomena as being due to the action of liquids on gases already absorbed by gold and platinum, whereas his results are obviously due to the action of these sulphides upon the metal itself. Further, these electric currents, as produced by Professor Becquerel, were "very feeble," while those described by the author of this paper have such an intensity as to be able to perform the functions of an electrotyping cell, it being, therefore, impossible that "capillary affinity plays a very important part in their production," as is asserted by Professor Becquerel in the case of the electric currents he describes.

DETERMINATION OF ALKALIES IN MINERALS, &c., BY IGNITION WITH CARBONATE OF LIME AND SAL-AMMONIAC.*

By J. LAWRENCE SMITH.

1. IN this description of separating and determining the alkalies, it is my intention to give the minutest details, although it may be thought useless by some; but numerous analyses have given me the experience here detailed; and I am convinced that analytical chemists, if they follow them out, will never resort to any other known method after a few trials; and if there be a better method, it is yet to be discovered. The presence of boracic, hydrofluoric, and phosphoric acids in the minerals in no way interferes with the process. Even in silicates *soluble in acids*, I prefer this method, in common with other analysts, for its ease and accuracy.

2. During the latter part of 1852 I made the researches, the details of which were published early in 1853.† Since that time I have employed the process many hundreds of times with the greatest satisfaction, most accurate results, and ready manipulation; some minor points were not completed satisfactorily until several years after the first notice of the method; these have been subsequently perfected, and in my mind there is nothing further now to be desired. I might state that many analytical chemists have for years constantly used this process to the exclusion of all others.

3. The purpose of this article is to give all the perfections, and a minute detail of the manipulations, with whatever precautions are necessary, all of which are simple and easily executed. In the two articles on the subject of alkali determination in minerals, published in 1853, the whole subject was reviewed, which is needless to recur to now. I then reviewed the process by caustic baryta and its salts, by hydrofluoric acid, also detailing some experiments on the separation of the different alkalies from each other, microscopic examinations of the same, &c. It was shown that, after the caustic alkalies, the most powerful agent to attack silicates at a high temperature is caustic lime, a fact not new to chemists, for as early as 1847 I used this process for attacking silicates, and others had done the same prior to that period. But for the purpose of arriving conveniently at *a quantitative determination of the alkalies in silicates*, certain methods of manipulation, quantity of material, admixture, &c., had to be discovered, and in them resides the success of my process—converting the most difficult parts of the analysis of a silicate into the easiest.

4. The methods of analysis of the silicates by caustic baryta and its carbonate are well known; but for various reasons fully detailed by Rose, in his "Analytical Chemistry," are now no longer used. The method still employed extensively is the one proposed by Berzelius with hydrofluoric acids, and when applied with numerous precautions, it seems to decompose all silicates; still, according to Rose, there are siliceous compounds that cannot be completely decomposed by hydrofluoric acid.* Dismissing all criticism, I at once proceed to the method which is the subject of this article.

5. *Decomposition of Silicates by Ignition with Carbonate of Lime and Sal-Ammoniac.*—This mixture of carbonate of lime and sal-ammoniac is used simply for the purpose of bringing, in a most thorough manner, caustic lime to act upon the silicates at a red heat.† The first step in the process is to have pure *carbonate of lime.*

6. This is made in my laboratory as follows:—Take as good marble as can be conveniently found (not dolomitic), or calc spar, and dissolve in hydrochloric acid. (It is not necessary that the acid be perfectly pure). Add an excess of the marble and warm the solution; to it add lime-water or some milk of lime, made from pure or nearly pure lime, until the solution is alkaline to test-paper; the lime is added to precipitate any magnesia, phosphate of lime, &c., that may have been in the marble. Filter this solution, and, after heating it to at least 160° F., precipitate with carbonate of ammonia.‡ The carbonate of lime thus precipitated is to be thrown on a filter and well washed with pure rain-water or with distilled water.

7. Thus prepared, the carbonate of lime is a dense powder and perfectly pure; or, if it contain any impurity, it will be a trace of carbonate of baryta or strontia, which in no way interferes with the use of the carbonate of lime.

8. *Sal-Ammoniac.*—To give to this reagent the most convenient form, take fragments of clean sublimed sal-ammoniac, dissolve them in water over a gentle fire, filter, evaporate the filtered solution over a steam-bath, or on a sand-bath, or any other convenient gentle heat, and as the small crystals deposit themselves, stir the solution to keep the crystals small; when one-half or two-thirds of the sal-ammoniac is deposited, pour off the liquid without waiting for it to cool, throw on a cotton filter, and dry the crystals at the temperature of the atmosphere. In this way sal-ammoniac is furnished that is easily pulverised.

9. *Vessels for Producing the Decomposition.*—The ordinary platinum crucible can be employed for this purpose, and is now most commonly used, and for many years was used by myself. It is, however, found that, while this method exceeds in precision and ease all other known methods for alkali determinations in silicates, there was yet a very minute quantity of alkalies lost by volatilisation, and while the method gave satisfaction to those who

* From "Select Methods in Chemical Analysis," by W. Crookes, F.R.S., &c. London: Longmans.

† Shortly after my first publication, M. St. Claire Deville made known his method of analysing the silicates by *fusion* with lime; but the nature of his process, and the objects to be arrived at, were quite different from those attained by the process under consideration.

* The process used by Deville in fusing with lime is in most cases better than that by hydrofluoric acid, and one that I should use in preference to all others, except the one now being described.

† Chloride of calcium at a red heat will dissolve more or less caustic lime.

‡ This precaution must not be overlooked, as it is desirable to obtain the precipitated carbonate of lime as dense as possible. If the carbonate of ammonia be added to the cold solution, the precipitate, at first gelatinous, will ultimately become much more dense and settle readily; the same is true if the mixture be heated after the addition of the carbonate of ammonia; but in neither case will it be as dense as when the carbonate is added to the hot solution of chloride of calcium. The reaction in this process of analysis is in no way effected by the form of the carbonate of lime; but, by using the denser form, the mixture occupies less space in the crucible in which it is heated.

used it, I yet continued my researches to overcome even this small loss. This has been successfully accomplished, and for some time I have been in the constant habit of using an improved form. Instead of the ordinary platinum crucible, I use an elongated one, which may be made of various dimensions. The one employed, with from ½ to 1 grm. of silicate, is of the following form and dimensions.

10. An elongated slightly conical crucible with rounded bottom, and having a cover with or without a central wire to hold the cover; its length is 95 m.m.; diameter of opening, 22 m.m.; diameter of small end, just at the turn of the bottom, 16 m.m.; and weighs about 35 or 40 grms. It can be made lighter, but experience has shown that it is better if stiff and solid. Messrs. Johnson and Matthey, Hatton Garden, London, have made a number for me, and they have my drawings and directions. It is thus made for the purpose of having that portion of the crucible containing the mixture heated strongly, while the upper portion is below a red heat.

11. *Manner of Heating the Crucible.*—If the ordinary crucible be used, it is heated in the manner usually employed for the fusion of silicates. If the new form of crucible be employed, then the upper part may be grasped by a convenient metallic clamp in a slightly inclined position, and a moderate blast from the table blowpipe made to play upon it for about twenty-five or thirty minutes. But now gas is to be found in every well-mounted laboratory, Bunsen burners of all dimensions are used, and, when properly applied, can be made to give gradations of heat, from the mildest to that sufficient to melt cast-iron. A simple, cheap, and convenient furnace, with a properly arranged draft, can be made to accomplish all silicate fusions without the aid of any manual labour, and therefore I employ such an appparatus, of which a description will be given at the end of this article.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

May 4th, 1871.

Dr. WARREN DE LA RUE, F.R.S., Vice-President, in the Chair.

THE following gentlemen were elected Fellows:—R. S. Best, C. S. Cross, W. H. Darling, G. H. Ogston, J. Schweitzer, W. A. Smith.

Dr. VOELCKER delivered a lecture "*On the Productive Powers of Soils in Relation to the Loss of Plant Food by Drainage.*"

The lecturer began by showing the futility of the belief that a soil-analysis could reveal whether a land was productive or not. To those who only imperfectly know the teachings of modern agricultural science it appears very simple to remedy a deficient soil by finding out, through analysis, the wanting constituent, and then to supply them. But this is not so. Not only is it difficult exactly to analyse a soil, but many other conditions besides the composition of the land have to be observed. Experience has furnished examples that two soils may be equal as to the respective amounts of potash, soda, lime, or phosphoric acid they contain, and yet be very different in their productiveness. The mentioned substances may be in different states of combination. Then, much depends on the physical properties of a soil. Land may contain all the important plant foods and still be yielding but poor crops, if it possesses not sufficient depth. A further point of consideration is the character of the undersoil and its relation in the situation to the surface soil. Lastly, climatological circumstances have to be considered. These two latter conditions are not revealed by soil analysis. Of course it is not to be denied that there are cases where analysis may ascertain and remedy the deficiencies of a soil. It is well known that in spite of good physical conditions of a soil, and of its possessing useful constituents, as potash, phosphoric acid, &c., it yet may be barren, simply because some injurious substance, —as, for instance, iron sulphate—is present in it. Here an analysis of the soil shows whence the mischief arises and suggests the remedy. And so it is with regard to substances which have a beneficial effect upon a land. Yet, in both these cases, the amounts may be so small as not to permit their exact determination by analysis. The addition of 3 cwts. of good superphosphate of lime to 1 acre of soil, 6 inches deep, increases the turnip crop in a favourable season from 6 to 10 tons per acre. Now these 3 cwts. to 1 acre hardly add 1-60,000th per cent of phosphoric acid to the land, and this small portion can, by analysis, certainly not be estimated with accuracy. More than anything this fact shows the futility of attempting to determine the productiveness of a soil by a mere analysis. It also obliges to oppose the views of those who advocate that in a system of rational farming there should be kept up a debtor and creditor account as regards the constituents which are removed from the soil in the crop grown upon it and the quantity of fertilising matter restored to it in the shape of manure.

The fertility of the soil cannot be maintained, much less increased, if only as much fertilising constituents would be applied to the land as one removes from it in the crops. Dr. Voelcker thinks that three to five times as much fertilising matter have to be put upon the land than is taken out from it in the crops.

Dr. Voelcker then discussed the relative values of various mineral salts as manures, quoting in support of his views the results of the classical field experiments of Lawes and Gilbert, and this, then, led the lecturer to speak of the examination of land drainage waters. Lawes and Gilbert, throughout a long series of experiments on the growth of wheat, have experienced a great loss of nitrogen, no matter whether ammonia salts or nitrates or nitrogenous organic matters were applied to the crop. Similar loss was found when barley or meadow hay was grown. The amount of nitrogen supplied in the manures was greater than that recovered in the increased produce.

It appeared to Dr. Voelcker that the nitrogen lost might have passed into the drain, and, at his request, Messrs. Lawes and Gilbert directed holes to be dug in the experimental wheat-fields at the end of each drain, passing right through the middle of each experimental plot. An opportunity was then afforded to collect the drain-waters, which then had been analysed by Dr. Voelcker. Of course it was known with what manures each plot had been treated.

The waters were collected—

1866.	Dec. 6.	At a full flow of the drain.
1867.	May 21.	,, ,,
1868.	Jan. 13.	,, ,,
1868.	April 24,	,, ,,
1869.	Dec. 29.	At an enormous flow of the drain.

A large table hung in the room contained the detailed figures of the analyses. It showed the relation of nitrogen as nitrates and nitrites found in the drain waters to the various manures employed. There would have to be considered the loss of rain-water by evaporation, but on this point as yet no reliable data exist.

But it is clear, from all the observations that, in whatever form the nitrogen is applied to the soil, a large proportion of it is carried off chiefly in the form of nitrates. Nitrate of soda, especially, seems to be rapidly removed by the rain. It should, therefore, be applied to the soil late in spring, the best time in average season being, probably, the middle of March. Farm-yard manure, on the other hand, experience has shown is best applied in autumn.

At all times of the year, but especially during the active period of growth of the crops, nitrates are found in the watery liquid which circulates in the land, whereas ammonia salts are never met with in any appreciably large quantities. It may therefore be assumed that it is chiefly, if not solely, from the nitrates that the crops build up their nitrogenous organic constituents.

Dr. Voelcker's analyses of drainage waters further showed that potash and phosphoric acid, which certainly are the most important mineral constituents for the plant, are almost entirely retained in the soil, whilst the less important, as lime or magnesia, or sulphuric acid, pass with greater readiness out of the land.

The interesting lecture concluded by pointing to the importance of attaining at an accurate knowledge of the capacity of different soils to work up, so to speak, the crude fertilising matters into suitable food for the plants.

The Chairman, in proposing a vote of thanks to the lecturer, expressed how highly the Society appreciated the paper just read. Referring to the observation that the soil cannot retain some salts, especially nitrates, he remarked how important it was to put the various manures at the proper season upon the land. Alluding to the field experiments of Messrs. Lawes and Gilbert, he said that the facts brought to light in those investigations will form the most valuable material for theoretical speculations for a long time to come. He finally expressed his regret at the necessitated absence of Drs. Frankland and Odling.

Dr. Gilbert fully agreed with Dr. Voelcker as to the inutility of soil analyses. He, too, regretted Dr. Frankland's absence, as their views on the subject of the lecture differed somewhat. Dr. Frankland spoke of possible mixtures of the waters from plot to plot; but such had not been the case. As to the difference between the results of the drain-water analyses made by Dr. Frankland and those made by Dr. Voelcker, he (Dr. Gilbert), ascribed to the circumstance that Dr. Frankland had only samples of dribbles of the drains, whilst the samples investigated by Dr. Voelcker were collected at full flows. Referring to Dr. Voelcker's observation, that such important constituents as phosphoric acid and potash were not carried out from the ground, Dr. Gilbert remarked, that even by an increased addition of ammonia to the soil, no increase of phosphoric acid in the drain waters was to be noticed. This seems to destroy the theory according to which ammonia serves to dissolve the phosphoric acid. The speaker then referred to some experiments regarding the evaporation of rain water, which are carried on at present at Rothamsted.

Dr. Marsden thought that great analogy exists between animal and vegetable physiology. The soil does not retain those substances it has no need of, but holds well those necessary for the life of the plant. Of course, how they are retained we do not know with certainty. From the circumstance that nitrates do readily leave the ground, whilst no ammonia is met with in the drain waters, he concluded that nitric acid is not absolutely necessary for the plant.

Mr. Warington could not clearly see the analogy drawn by the previous speaker; the body is a *living* filter, the soil is not. As to the opinion of nitric acid not being required by the plant, he thought that the wonderful crops obtained with nitrate of soda manures are sufficient fact to refute it. Alluding, then, to the main results of Dr. Voelcker's paper, he said that they spoke very much against the utility of applying sewage manure by irrigation, since this would have to go on during periods when the activity of the vegetation is almost nought, and would thus entail loss of much valuable plant constituents. As to Dr. Voelcker's statement that nitrates are not well retained by the soil, he thought there were some experiments on record which would tend to show the contrary.

Mr. Grantham briefly mentioned that there are now drain gauges set up on the fields where irrigation experiments are carried on under the direction of the British Association Committee, and he thinks that soon some results will have been obtained bearing upon the question of the evening.

NOTICES OF BOOKS.

Die Prüfung Chemischer Gifte, ihre Erkennung in Reinem Zustande und ihre Ermittelung in Gemengen. Von Adolf Duflos, Docteur der Philosophie und Medicin, Königlichen Geheimen Regierungsrathe und Professor. Ein Leitfaden bei Gerichtlich-Chemischen Untersuchungen für Aerzte, Apotheker, Gerichtliche Chemiker und Criminal Richter. Mit vierzig in den text gedruckten abbildungen nach original zeichnungen. Ferdinand Hirt, Verlags und Königliche Universitäts-Buchandlung, Breslau. 1867.

The Chemical Testing for Poisons: their Detection in the Pure State as well as when they occur in Mixtures. By Adolf Duflos, M.D., Ph.D., Privy Councillor of H.I.R. Majesty of Germany and Prussia, and Professor at Breslau University. A Guide to Forensico-Chemical Research for Physicians, Apothecaries, Forensic Chemists, and Judges sitting in Criminal Courts. With 40 woodcuts prepared from original drawings. F. Hirt, Breslau. 1867.

From the preface of this volume we learn that the author has embodied, in the 210 pages constituting the book, the chief and leading features of a series of lectures given by him annually, for a consecutive period of twenty-five years, on the subject of chemical toxicology. The work is particularly intended as a guide-book for those German pharmaceutists who, under the regulations of the Medicinal-Polizei of Prussia, are occasionally required to institute chemico-forensic researches in cases where the detection of poisons may be required.

The arrangement of the contents of this useful work is novel and ingenious. It is well-known that most toxicologists arrange the various poisonous substances they treat of according to the action they exercise upon the living human system. The author has, very wisely, we think, introduced a different arrangement, more based upon chemical principles, viz.:—Poisons of the Chloroïd kind (chlorine and alkaline compounds, bromine, iodine, and their alkaline compounds); Poisons belonging to the Acid Substances, sub-divided into Mineral and Vegetable Acids; Alkaline Poisons (caustic alkalies, caustic baryta, &c.); Carbonates of the Alkalies; Sulphuretted Alkalies; Poisons belonging to the class of Saline Substances (alum, nitrate of potassa, chloride of barium, carbonate of baryta, chromate of potassa, &c.); Poisons of the Metalloid kind (Phosphorus); Poisons derived from the heavy metals (among these we quote as instances—Arsenical and antimonial, lead, copper, mercurial poisons); Cyanogen Poisons (the various poisonous compounds of cyanogen, inclusive of oil of bitter almonds and the like); Poisons derived from, or belonging to, the Alkaloids (coniine, nicotine, aniline, atropine, &c.). Since the author has had a very extensive practice as forensic chemist, the various processes detailed in this work for the detection of poisons, either by themselves, or in complex mixtures with organic matter, are only those which, by practical experience, he has found to answer the purpose readily and with certainty, if the operator attends to the directions given, which, as far as regards the necessary apparatus, are illustrated with excellent woodcuts. This little volume contains a good amount of valuable information, very clearly and practically described, and its publication has highly benefitted the German pharmaceutists, who, as *kreisxapotheker* (district pharmacists), are often required to test, for the presence of poisonous or noxious substances, articles of daily use. For this purpose full directions are clearly set forth.

Proceedings of the American Pharmaceutical Association at the Eighteenth Annual Meeting, held in Baltimore, September, 1870. Philadelphia: Sherman and Co. 1870.

THIS volume of 352 pages contains, in addition to subject-matter more particularly interesting to the Members of the American Pharmaceutical Association, a series of valuable papers relating not only to pharmacy, but extending to various other subjects bearing upon physical science in general. Among these, we quote the titles of the following papers and memoirs, regretting that space forbids us to do more at present:—"On a Morphio-metric Process for the Pharmacopœia," by W. Procter, jun.; "On Filtering-Papers and Filters," by J. M. Hirsch; "On the Specific Gravities Indicated by Baumé's Hydrometers," by Dr. W. H. Pile; "Glycerine and its Qualities," by J. P. Remington. The work, moreover, contains an excellent review of the progress of pharmacy, pharmacognosy, and pharmaceutical chemistry, with abstracts from a large number of periodicals published in different languages; reports of committees; laws relating to pharmacy in the states of Maryland, Rhode Island, and Pennsylvania; list of publications received; and concludes with a comprehensive alphabetical index. We must not omit to call attention to some valuable communications on the hydrate of chloral, from the hands of several gentlemen who have been practically engaged in its preparation and the investigation of its properties.

CORRESPONDENCE.

PRECIPITATION OF MUDDY MATTER FROM WATER BY SALINE SOLUTION.

To the Editor of the Chemical News.

SIR,—In No. 554 of the CHEMICAL NEWS (July 8th, 1870) I learn that Dr. C. Schlœsing has re-discovered the fact that muddy waters are clarified by dilute solution of various lime salts, also by caustic lime. I say a *re-discovery* because, in No. 435 of the same journal (April 3rd, 1868), I announced that a great many neutral saline solutions had the same effect upon such waters, chloride of calcium being amongst them.

Dr. Schlœsing states 1-10000th part of this salt in one part of muddy waters clarifies them "in a moment." By allowing some hours for the operation, however, one grain of this salt is sufficient for 10 ounces, or say 1 to 50,000.

In the same communication where these results of mine are given, I also stated that magnesia had the same effect as saline solutions upon these waters: this being comparatively a tasteless substance, its use would perhaps be preferable to that of any other for purifying potable waters.

You observe, in your notice of this paper by Dr. Schlœsing, that Professor Johnson explains the clearing of muddy waters by certain bitter or other vegetable substances; but I do not know that he ever explained the *rationale* of the action of saline solutions upon such waters, or even noticed they had any action on them. I conceive this to be quite different for the two kinds of substances used, as will be seen on reference to my communication.

I will only further notice that, in a paper "On the so-called Molecular Movements of Microscopic Particles," I find Professor Jevons has observed the precipitation of clay by the same kind of substances as those cited here, and he attributes this, I believe, to the circumstance that these saline additions render the water a conductor of electricity; the movement and suspension of these clayey particles, before such additions, being supposed by him to be owing to the non-conducting power of pure water: the particles themselves he infers to be charged with electricity.

It is difficult to conceive how they become charged with electricity, or retain it when charged for any length of time, in a liquid which is by no means a *non*-conductor. I should rather refer the *suspension* and *precipitation* of these particles to chemical, and their *movements* (as Mr. Dancer does) to thermal, agency, if these cannot be explained or attributed to the simple effects of manipulating such substances under a high-powered microscope.—I am, &c.,

WILLIAM SKEY.

Wellington, New Zealand,
March 3, 1871.

MISCELLANEOUS.

The Royal Society.—The following gentlemen are reecmmended by the Council for election into the Royal Society, on June 8th; William Henry Besant, M.A.; William Budd, M.D.; George William Callender, F.R.C.S. William Carruthers, Esq.; Robert Etheridge, F.R.S.E.; Frederick Guthrie, B.A.; John Herschel, Capt. R.E.; Alexander Moncrieff, Capt. M.A.; Richard Quain, M.D.; Carl Schorlemmer, Esq.; Edward Thomas, Esq; Edward Burnet Tylor, Esq.; Cromwell Fleetwood Varley, C.E.; Arthur, Viscount Walden, P.Z.S.; John Wood, F.R.C.S.

Scientific Differences.—A great deal has been made of the differences of opinion of medical witnesses in disputed cases of injury for which compensation is claimed by legal processes. We have taken occasion to point out that these differences are, in great measure, the residuum of a great mass of agreement. For, in the vast majority of cases, doctors do agree; and such cases are settled by arbitration out of court. It is commonly only the cases which admit of various prognostication, and on which an agreement is not arrived at, that come into court. Under any circumstances, a large proportion of "difficult cases" are cases in which the medical opinion is arrived at by a balance of probabilities rather than of certainties, and by a varying estimate of the uncertain factors in the problem. But how is it with experts not medical, dealing with matters of fact, and employing the simple and unerring processes which physical science supplied? We read in the CHEMICAL NEWS of "buyers' analysts" and "sellers' analysts," who always manage to give different results in the examination of the same samples in commerce. Here we are a little puzzled; and if it be possible, as we read, for unconscious bias to add or take away 5 per cent of soluble phosphate from a sample, we shall expect to find chemists treating medical difficulties of agreement, in whatever case, with the utmost possible indulgence.—*British Medical Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Moniteur Scientifique, April 1 and 15, Nos. 343 and 344 (double number), 1871.

This number opens with the report, by Dr. A. Proust, on the—

Means of Preventing Asiatic Cholera from Invading Europe.—A very lengthy document, but one of considerable value and interest.

The following original papers bear upon chemistry and allied sciences:—

Nature of the Purgative Principle contained in Senna.—Drs. E. Bourgoin and M. Bouchut.—The drug here spoken of has been frequently the subject of chemical analysis by various scientific, as well as pharmaceutical chemists, among whom we quote MM. Bouillon-Lagrange, Braconnot, Lassaigne, Batka, Kubly, Dragendorff, and others. The authors describe, in this lengthy memoir, the mode of their operations, as well as the physiological effect of the substances they have separated from the senna leaves, and which substances are mucilaginous matter, cathartine, catharto-mannite, cathartic acid, and chrysophanic acid. It remains, however, an undecided matter whether these principles are, as such, present in the dried senna leaves, or are produced by the reaction which ensues when the leaves are treated with hot water, as the first operation required to prepare the various substances above named, none of which are obtainable in crystalline state.

Intervention of the Académie des Sciences in the General Questions of the Scientific Organisation of France.—Dr. H. Sainte-Claire Deville.—A lengthy and important paper, but one of local interest only.

Propagation of Heat through Two Layers of Different Liquids: Posthumous Researches of Dr. Despretz.—Communicated by Dr. Saigey.—The contents of this important paper, chiefly consisting of a series of tables exhibiting the results of the experiments, are not well suited for abstraction, an observation which applies to the following.

Calorific Effects of the Sun at the Two Extremities of the Terrestrial Atmosphere.—Dr. Saigey.

Although strictly belonging to the domain of astronomy, we quote the titles of the two following papers:—

Observations on the Black Colour of the Heavens (Noir du Ciel).—Dr. Saigey.

Zodiacal and Antizodiacal Light.—Dr. Saigey.

Observations on the Present State of Meteorology.—Dr. Saigey.—From this paper we quote the following particulars relating to the periods since which meteorological observations have been more or less regularly and continuously made:—Paris, 1735; by Dr. van Swinden, at Zwanenberg (half way between Amsterdam and Haarlem), 1736; Rev. Bordier, S.J., at Chandernagor, India, 1741; Rev. Amyot, S.J., at Pekin, China, 1757; at Neuchâtel, Switzerland, 1754; at London, by Professor Cavendish, 1763; at Brussels, by the Rev. Chevalier, 1763.

Polytechnisches Journal von Dingler, first number for April, 1871.

This number contains the following original paper relating to chemistry and collateral sciences:—

Crude Gold obtained at Lend, near Gastein (Austria).—E. Priwoznik.—This paper treats on a peculiar kind of thin matt, or scoria, which very strongly adheres to, and outwardly covers the ingots of gold obtained by amalgamation at the locality above named. Deducting such substances as are obviously accidental in this scoria, it was found to consist, in 100 parts, of the following sulphurets:—Silver, 61·99; iron, 29·04; lead, 5·33; copper, 3·64. The authorities of the Mint at Vienna, of which the author is the chemist, having been consulted with the view to ascertain the best and cheapest means to prevent the formation of this matt, a series of experiments were made by the author with the crude gold previous to fusion. It was found to consist, in 100 parts, of—Gold, 66·56: silver, 23·69; mercury, 5·78; iron, 1·14; lead, 0·66; copper, 0·87; sulphur, 0·47; antimony, a trace; silica, a trace. The experiments on the smelting of this gold proved that, if it were treated with a mixture of 2 parts of saltpetre and 1 part of borax in graphite crucibles, a metal was obtained free from adhering scoria, and composed, in 1000 parts, of 723 of gold and 250 of silver. The ingots were quite bright and smooth.

Journal de Pharmacie et de Chimie, October, 1870.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Thermo-Chemical Researches on Sulphurets.—Dr. Berthelot.—This essay is divided into the following chapters:—Reaction of the alkaline sulphurets on solutions of metallic salts; reaction of acids on alkaline sulphurets; reaction of sulphuretted hydrogen on various metallic salts; and reaction of acids on metallic sulphurets.

Chemical Research on the Crystalline Substance which Covers the Vanilla Pod.—M. P. Carles.—This paper treats on the nature of the crystalline substance which may frequently be seen on the vanilla pods, and have been considered by various authors to consist of benzoic or cinnamic acid, or coumarine. The author finds that this crystalline matter fuses at about 81°; boils, with partial decomposition, at 280°; is very readily soluble in alcohol, ether, chloroform, and sulphide of carbon; difficultly soluble in cold water; exhibits a strongly acid reaction to blue litmus paper; and decomposes carbonates. Elementary organic composition, $C_{16}H_8O_6$. The author has prepared several salts of this acid; but, as to its true chemical constitution, his labours are not yet completed.

New Process for the Preparation of Bromhydric Acid.—Drs. Champion and Pellet.—This process is based upon the reaction ensuing between bromine and paraffin, the former being heated to about 65°, the latter to 185°, and the operation conducted in suitably arranged apparatus; by continuing the action until no more bromhydric acid is formed, there remains a residue, consisting, in 100 parts, of—Carbon, 63·0; hydrogen, 5·3; bromine, 31·6. The bromhydric acid thus obtained has, at 0°, a sp. gr. of 1·78; its formula is $BrH,2HO$. When heated, hydrobromic acid gas is given off and a hydrate obtained, which boils at 126°, and has a sp. gr. of 1·48; formula, $BrH,10HO$.

Conversion of Chloral into Aldehyde by Inverse Substitution.—M. Personne.—When hydrate of chloral is treated with zinc-dust and hydrochloric acid, the chloral-hydrate is converted into aldehyde, which may thus be readily obtained. The author has also obtained a compound of anhydrous chloral with ammonia, $C_8HCl_3O_2,NH_3$, or the aldehydate of trichlorated ammonia, comparable to the aldehydate of ammonia, $C_4H_4O_2,NH_3$. The body first named is prepared by causing dry ammoniacal gas to act upon small quantities of anhydrous chloral, which should be strongly cooled. The substance in question is a white, fusible, volatile body, the odour of which is comparable to aldehydate of ammonia. When larger quantities of anhydrous chloral (say 2 or 3 grms.) are operated upon, there is also generated a liquid which was found to consist of chloroform and formamide.

November and December (double number), 1870.

This number contains no original papers.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 5, 1871.

This number contains the following original papers and memoirs:—

Chlorine Substitution Products of Ether.—O. Jacobsen.—The author describes, at great length, and with the quotation of a large number of complex formulæ, the products of the action of chlorine upon ether. These products are—A real monochlor-ether, boiling at 98° (formula, $CH_3.CHCl.O.C_2H_5$; a dichlor-ether—

$$CH_3Cl.CHCl.O.C_2H_5;$$

a trichlor-ether, $CHCl_2.CHCl.O.C_2H_5$; a tetrachlor-ether—

$$CCl_3.CHCl.O.C_2H_5;$$

and, lastly, a pentachlorether, $CCl_3.CCl_2.O.C_2H_5$.

Use of Bromine instead of Chlorine for Analytical Purposes.—H. Kämmerer.—The contents of this paper record the fact that, instead of chlorine-water, a solution of bromine in the same liquid answers not only as well as, but, in many instances, better than chlorine-water, while there is neither difficulty in keeping, nor, when required, in preparing the bromine solution.

Organic Sulphuric Acid Derivatives.—H. Kämmerer.—This paper contains the rectification of some particulars concerning sulphobenzoic acid anhydride, formerly made public by the author and Dr. Carius; but this communication is only a preliminary notice.

Contribution to our Knowledge on Sulpho-Nitrogen Acids (Schwefelstickstoffsäuren).—A. Claus.—The continuation of the author's essay on sulphamine acids. The substance here treated of is sulphydroxylaminate of potassa, $(NO_2H_2).(SO_3K)$.

Constitution of Chrysanissic Acid.—H. Salkowski.—A lengthy monograph describing a series of reactions and the behaviour of chrysanissic acid (the product of the action of fuming nitric acid upon nitroanissic acid) with various reagents, in order thereby to elucidate the true constitution of chrysanissic acid. Formula, $C_7H_5N_3O_7$.

Some of the Nitro Compounds of Anthrachinon.—R. Bœttger and T. Petersen—And—

Observations and Remarks on the above-mentioned Essay—C. Liebermann—Are, although valuable, not suitable for abstraction, owing to their great length.

Nature and Constitution of Tannic Acid.—H. Scbiff.—The main point of interest of this valuable essay is, that tannic acid is an alcoholic anhydride of gallic acid, very probably digallic acid. The relation between these acids is elucidated by the following formulæ:—

$$C_6H_2\begin{cases}CO.OH\\OH\\OH\\OH\end{cases}$$

Gallic acid.

$$C_6H_2\begin{cases}CO.OH\\OH\\OH\\O\end{cases}\qquad C_6H_2\begin{cases}OH\\OH\\CO.OH\end{cases}$$

Tannic acid.

Law of Dulong and Petit in Gases.—Dr. F. Mohr.

Absolute Magnitude of Chemical Motion (Affinity).—Dr. F. Mohr.

Metallic Nature of Hydrogen.—Dr. F. Mohr.

Lecture Experiments.—Dr. A. W. Hofmann.—This paper treats on the following subjects:—Eudiometer with movable wires for conducting the spark, illustrated with a woodcut; doubling of the volume of carbonic acid when converted into carbonic oxide by absorption of carbon. This experiment cannot be described without the reproduction of the woodcut just mentioned.

Isodicyanic Ether Compounds which Occupy the Mean between the Cyanic and Cyanuric Acid Ethers.—Dr. A. W. Hofmann.—This essay contains the following sections:—Diphenyl-allophanic acid ethylic ether, methylic ether, amylic ether; sulphuretted diphenyl-allophanic acid amylic ether; action of phenol upon phenyl-dicyanate; diphenyl-biuret; triphenyl-biuret.

Contribution to the History of Naphthazarine.—Drs. A. A. de Aguiar and A. G. Bayer.

Isomeric Cyanate of Potassa.—A. Bannow.—The author communicates, in this paper, some of his experiments on the action of

caustic potassa upon paracyanogen, whereby a salt is obtained forming long needle-shaped crystals, and found, on analysis, to consist of—C, 14·8; N, 17·0; K, 48·2; O, 19·72; a salt, therefore, of the same composition, and agreeing in properties with the ordinary cyanate of potassa. This salt is also formed when chloro-cyanogen is passed into a cold aqueous solution of caustic potassa.

Preparation of Aceto-Chloral from Aldehyde.—A. Pinner.—After first referring to a series of experiments formerly made on the action of chlorine upon aldehyde, the author describes, in this paper, other experiments of the same nature, but so conducted as to eliminate all hydrochloric acid at the moment of its generation. This was effected by adding to the aldehyde lumps of marble, care being taken also to cool the liquid by means of ice. After the action of the chlorine had been continued for about two days, the fluid was distilled from the chloride of calcium; to the aqueous solution thus obtained, four times its bulk of concentrated sulphuric acid was added, and again distilled. The result was that the author obtained about 20 grms. of a fluid which was found to possess all the properties of aceto-chloral, also agreeing therewith in the property of being converted, by the action of alkalies, into formic acid and chloroform.

Combination of Aldehyde and Sulphaldehyde.—A. Pinner.—The contents of this paper contain the description of a new compound which was obtained by the author while preparing sulphaldehyde according to the directions given for that purpose by Dr. Weidenbusch (*Ann. Chem. Pharm.*, vol. lxvi., p. 158). The new body here alluded to is an oily substance, $C_4H_4O+C_4H_4S$; the quantity of sulphur was found by the author to vary from 30·65 to 31·39 per cent. This oil freezes at −8°, and melts at −2°; it boils at 35° with partial decomposition. The vapour density of this oil was found to be 61·2.

Conversion of Bromobenzoic into Isophthalic Acid.—E. Ador and V. Meyer.—The potassium salt of pure mono-bromobenzoic acid is fused at a strong heat along with its own weight of formiate of soda; the resulting deep brown mass is treated with water, the solution acidulated with hydrochloric acid, and next well shaken up with ether. The acid which is left after distilling off the ether is dissolved in ammonia, purified by means of animal charcoal; boiled with water, in order to extract any benzoic acid which might have been regenerated; then made into a barium salt; and the pure isophthalic acid obtained by the decomposition of this salt. The acid thus obtained fuses at 300°, sublimes without decomposition, is soluble in boiling-hot water, and consists, in 100 parts, of—C, 57·83; H, 3·62; O, 28·95. The baryta salt is crystalline, and readily soluble in water; the silver salt is a precipitate insoluble in water.

Biuret and Analogous Compounds.—Dr. A. W. Hofmann.—This lengthy essay is divided into the following sections:—On the preparation and properties of biuret (discovered by Dr. Wiedemann in 1847; see Poggendorff's *Annalen*, vol. lxxiv., p. 67, 1849); substituted biurets; action of ammonia on allophanic acid-ethyl ether; action of aniline on the same body; action of ethylamine on the same body; action of aniline on biuret; action of heat upon urea in the presence of amylic alcohol.

Observations and Remarks on a Paper by M. Mohr, "On the Unequal Conductibility of Heat by Gases."—Dr. R. Clausius.

Law of Avogadro.—A. Naumann.

Mellittic Acid.—Dr. A. Baeyer.—This memoir is divided into the following sections:—Prehnitic acid; mellophanic acid; prehnomalic acid, $C_{10}H_8O_8$; hydro-pyromellittic acid; bromalophthalic acid; tartrophthalic acid.

Annalen der Chemie und Pharmacie, April, 1871.

This number contains the following original papers and memoirs:—

Contribution to our Knowledge of Brom- and Dibrom-Benzoic Acid.—E. Angerstein, L. H. Friedburg, and H. Hübner.—This paper is the first part of a lengthy monograph on the isomerism of the aromatic acids, and is divided into the following sections:—On the brom-benzoic acid which is formed by the action of bromine on benzoate of silver; experiment made to try whether, by the conversion of β-brom-nitro-benzoic acid into meta-amido-benzoic acid, other amido-benzoic acids are formed; dibrom-benzoic acid, dibrom-nitro-benzoic acid, and dibrom-amido-benzoic acid; on the conditions of the generation of ortho-mono-brom-benzoic acid; examination of crude brom-benzoic acid to discover therein another acid than the ortho-mono-brom-benzoic acid fusing at 155°; action of bromine upon benzamide; action of bromine upon benzo-nitrile; researches on the preparation of meta-mono-brom-benzoic acid (brom-salylic acid).

Action of Chlorine upon Aldehyde.—G. Krämer and A. Pinner.—This lengthy memoir contains the following chapters:—Description of the mode of experimenting and the origin and properties of the substances operated upon; croton-chloral; croton-chloral-hydrate; dichlor-allylen; dichlor-dibrom-propylen; trichlor-crotonic acid; monochlor-crotonic acid.

Mulberry Leaves from Turkestan.—Dr. E. Reichenbach.—This paper contains, in the first place, a report from M. Adamoli, on the different kinds of mulberry trees met with, partly in a wild state, partly cultivated, in Turkestan (Central Asia). The average quantity of nitrogen contained in five different varieties of these leaves amounts to 3·73: while the Japanese mulberry leaves only contain 3·29 per cent, and Chinese mulberry leaves 3·13 per cent of nitrogen. There is added to this paper, as an appendix—

Essay on the Silkworm Disease, in reference to the Observations mentioned in the Paper of Dr. E. Reichenbach.—Baron von Liebig.

Boiling-Point and Specific Volume of Allylic Alcohol.—B. Tollens.—The boiling-point of the perfectly anhydrous allylic alcohol was ascertained to be 96°, tried on the first portion of this liquid; after being doubly rectified over lime, 94·5°. The specific volume (not to be confused with specific gravity, which, at 0°, is 0·7846) is 73·92.

Conversion of Formic Acid into Methylic Alcohol.—M. A. Lieben and M. A. Rossi.—The authors describe at length a series of experiments made with formiate of lime, taken in quantities of 10 grms. at a time, and submitted to dry distillation, care being taken to condense the volatile products by means of a cooling mixture. Among these products the authors found a comparatively small, yet perfectly recognisable, quantity of methylic alcohol. 250 grms. of the formiate of lime gave between 3 and 4 grms. of that fluid, which, in order to make quite sure about its nature, the authors converted into iodmethyl.

Estimation of Carbonic Acid in Spring Waters.—Dr. K. Knapp.—This paper contains the record of a series of experiments instituted by the author with the view to test the correctness and sensitiveness of Dr. Pettenkofer's method of estimating the quantity of carbonic acid contained in water, by adding, to a known bulk thereof, first, chloride of calcium solution, sal-ammoniac, and, next, a measured quantity of lime-water of known strength. After having been left quietly standing for fully twelve hours, the quantity of lime which remains in solution is estimated by titration with a solution of oxalic acid, 2·8636 grms. of that acid to 1 litre of water. Every c.c. of that solution corresponds to 0·001 grm. of carbonic acid. The point of neutralisation of the lime-water is ascertained by means of turmeric paper.

Excrements of the Common Bat (Rhinolophus hipposideras).—Prof. Wöhler.—After briefly referring to the researches on the excrements of the Egyptian bat by Dr. Popp (see CHEMICAL NEWS, vol. xxii., p. 202), the author states that Dr. Ehlers had the kindness to supply him with the material above named, taken from a locality where it had accumulated to a layer of 3 inches' thickness. This substance does not contain any trace of urea, nor any uric or oxalic acids; the bulk is made up of the undigested horny mass of the wings of insects. Dried at 100°, this substance gave 8·25 per cent of nitrogen, and left, after ignition, 6·25 per cent of ash, containing potassa, soda, lime, magnesia, oxide of iron, chlorine, sulphuric, silicic, and phosphoric acids, the latter being 36 per cent of the weight of the ash.

Butyric Acid from Various Sources.—Dr. C. Grunzweig.—(Preliminary notice.)—The main point of interest in this short notice is, that the butyric acid met with in the fruits of the carob tree (*Ceratonia siliqua*, L.) is isobutyric, not normal butyric acid.

Decomposition of Cyanogen by an Alcoholic Solution of Hydrochloric Acid.—J. Volhard.—Into an absolute alcoholic solution of hydrochloric acid gas cyanogen gas was passed. When the alcoholic acid solution is employed for this purpose undiluted, the result of the reaction is only the formation of sal-ammoniac; but, if the alcoholic fluid is previously diluted with more alcohol, oxamide is also formed, as well as oxalic ether, ethylic chloride, and some formic ether. The reaction takes place according to the formula—

$$C_2N_2+4C_2H_5OH+4HCl=C_2O_2(C_2H_5O)_2+NH_4Cl+2C_2H_5Cl.$$

Lecture Experiment to Prove that Mercury is Heated while a Galvanic Current Passes through it.—Dr. F. C. G. Müller.—Take a glass tube, 6 c.m. long and about 6 m.m. diameter; heat it before the blowpipe, and, while soft, reduce its diameter in the centre to ½ m.m., and next bend it to a U-shape; fill it with mercury, fasten it in a clamp, and dip afterwards in the metal the wires of a galvanic battery. This having been done, the metal (mercury) in the narrowed portion of the tube will be observed to boil rapidly, while a continuous series of sparks will be also exhibited.

Annales de Chimie et de Physique, August, 1870.

This number only contains the following original paper:—

Universal Method of Reduction by, and Saturation with, Hydrogen of Organic Compounds.—Dr. Berthelot.—This monograph, containing about 250 pages, is divided into the following sections:—Introduction; series of the properly so-called fatty bodies; aromatic series; nitrogenised bodies; complex and polymeric carburets; carbonaceous matters (*matières charbonneuses*).

Journal für Gasbeleuchtung und Wasserversorgung, No. 4, 1871.

This number contains the following original paper bearing upon chemistry and allied sciences:—

Changes of the Quality of the Water of Rivers.—Dr. H. W. Langhaus.—This essay treats on the effect which the passing of rivers through more or less densely populous districts has upon the quality of the water of such rivers. As an instance, the author gives an analysis of the water of the river Pegnitz, on entering the city of Nürnberg, and on leaving it. As might be expected, the total quantity of solid matter in the water is increased; for, while that amounts (in 100,000 parts, by weight) on entering the city to 20·82, it has increased on leaving to 21·17. For every litre of water flowing through the city, there has been added to it—Potassa, 0·0016 grm.; soda, 0·0013; oxide of ammonium, 0·0005; silica, 0·0004; nitric acid, 0·0016; chlorine, 0·0020; soluble organic matter, 0·0084; insoluble organic matter, 0·0023; suspended matter, 0·0084. On the other hand, the following substances have decreased in quantity to the litre of water by passing through the city:—Lime, 0·0006 grm.; magnesia, 0·0018; alumina and oxide of iron, 0·0002; sulphuric acid, 0·0002.

No. 5, 1871.

This number only contains the following original paper relating to chemistry:—

Hydrotimetry.—M. E. Grahn.—This paper is a review of, and reply to, a series of critical remarks, made by various parties, on a paper published on this subject in this periodical some time ago. The chief point of discussion is on the value of the various methods in use for estimating the hardness of the water.

Zeitschrift für Chemie von Beilstein, No. 3, 1871.

This number contains the following original papers:—

Estimation of the Value of Hydrate of Chloral.—Dr. C. Müller.—Since the value of the hydrate of chloral is indicated by the quantity of chloroform it yields when decomposed by caustic alkalies, the author places 25 grms. of the hydrate of chloral to be tested in a glass tube divided into 1-10th c.c.. The solid substance having been placed therein, a good cork is selected for closing the tube immediately after the addition of caustic potassa solution, and the tube, having been closed, is placed in a cooling mixture. After the first violent action has ceased, the reaction may be finished by shaking the tube for a few moments, after which it should be left standing for some hours quietly, in order to obtain a complete separation of the chloroform. The number of c.c. this fluid occupies in the tube, having been read off, has only to be multiplied with its specific gravity at the temperature of the fluid to yield, by a simple calculation, the percentage quantity of the chloroform thus formed.

Bromsulpho-Benzoic Acid and Acids Derived from it.—Dr. J. R. van Lennep.—This paper contains, in a catalogical form, the enumeration of the salts of ortho-mono-bromsulpho-benzoic acid, and treats on the action of bromide of phosphorus upon bromsulpho-benzoate of sodium, thihydro-brombenzoic acid and its salts, and meta-thihydro-benzoic acid.

New Mode of Formation of Para-Oxybenzoic Acid.—Dr. I. Remsen.—The main gist of this paper is, that when sulpho-benzoate of potassium is treated with fused caustic potassa, there is, along with oxybenzoic acid, also formed para-oxybenzoic acid. The author also observes that crude sulpho-benzoic acid should not be used for the preparation of pure oxybenzoic acid.

Action of Hydrogen (Sodium-Amalgam) upon Essential Oil of Bitter Almonds.—Dr. H. Ammann.—(Preliminary notice).—The author's scientific labours have been cut short, he having been killed (as we learn from this paper) while in the battle-field in the late war. When sodium-amalgam acts upon the essential oil of bitter almonds, either in aqueous or alcoholic solution, there are formed, beside benzyl-alcohol, simultaneously, two isomeric compounds, one of which is identical with Zinin's hydrobenzoine, while to the other the name of isohydrobenzoine has been given. This latter substance is a solid body, soluble in water to some extent, readily soluble in alcohol, and fusing at 119·5; formula, $C_{14}H_{14}O_2$. The author briefly mentions the action of chloracetyl, nitric acid, and chloride of phosphorus upon this substance, as well as upon hydrobenzoine.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, February, 1871.

This number contains the following original papers relating to chemistry and allied sciences.

Tea-Trade between Russia and China.—K. A. Popow.—This very lengthy essay contains some matters which are interesting to all who use the infusion of this herb, a national beverage with only three European nations, those which have the most extensive and oldest connections with Asia—viz., the Russians, English, and Netherlanders. Tea has been used in Russia since 1638; in the western parts of Europe, tea was first imported by the Dutch about the beginning of the seventeenth century.

The other papers in this number are strictly pharmaceutical.

NOTES AND QUERIES.

Nitrous Oxide.—Can any of your numerous correspondents inform me whether it is possible to convert nitrous oxide (N_2O) into nitric oxide (NO_2).—Inquirer.

Improved Bunsen Battery.—Having inquired from one of Professor Bunsen's assistants, I am able to inform J. McCulloch that he has not yet published an account of his improved battery.—E. W. P., Ploeckstrasse, Heidelberg.

Manipulating India-Rubber.—(Reply to F. Bankes.)—You will find the information you desire in Payen's "Précis de Chimie Industrielle," 5th edition, vol. i., pp. 186—235. This work is published by Messrs. L. Hachette and Co. (1867).

Analysis of Iron Ores.—(Reply to L. Peters.)—Consult "Select Methods of Chemical Analysis," by W. Crookes, F.R.S., &c. This work contains a very complete account of the subject you inquire after.

Notched Teeth.—Could any of your readers tell me the cause of notches they would oblige, as I have read somewhere they are a sign of syphilis, and have been told to the contrary.—Reader.

Welding Iron and Steel.—I am obliged to "A." for his kind consideration of my question, but I am not satisfied with his reply. I am aware that cast-steel cannot be welded at the heat at which iron is welded to iron—in that case it would, of course, undergo fusion and oxidation; but is there not a possibility of uniting them without raising the heat of the steel to the white heat at which iron is usually welded? Can it not be welded at a red heat with the care referred to in the making of chisels, and the application of some kind of flux (to defend the metal) containing iron or steel in a fine state, and, consequently, easily softened. Could a junction not be made which would give complete satisfaction? Such a process is said to be in actual practice, but perhaps it belongs to the category of processes that cold brazing belongs to.—W. A. Murray.

Valuation of Orchil.—(Reply to "Orchil.")—The colorific portion of the lichens may, according to Dr. Schutzenberger, vary from 2½ to 12 per cent. In order to estimate the value of orchil lichens, the author just named recommends a comparative assay, by macerating equal quantities (100 grms.) of the lichens with milk of lime for a few minutes, after which the mass should be filtered and pressed, and the filtrate treated with hydrochloric acid. The white-coloured pasty precipitate thereby produced should be left to drain on a fine silk sieve, and weighed. Dr. J. Stenhouse adds, drop by drop, a titrated solution of hypochlorite of lime to the calcareous extract of the lichens, so as first to call forth colouration; and when this has reached its maximum, more of the hypochlorite solution is added, so as to produce discolouration. By comparing the bulk of hypochlorite liquor required to discolour the calcareous extract of various samples of lichens, an approximative idea of their richness in colouring matter is gained. Lastly, 100 grms. of lichens may be treated with an aqueous alkaline solution, the solution thus obtained evaporated to 100 grms., and next treated with 30 grms. of ammonia, whereby the colour is produced. This having been done, a dyeing assay with non-mordanted wool will give some idea of the quantity of colouring matter formed. For a piece of wool 5 centims. long by 2 wide, there is applied from 0·5 to 1·0 grm. of orchil and 300 grms. of water; the dyeing is done on a water-bath, and the process continued at boiling-heat for half an hour.

MEETINGS FOR THE WEEK.

Tuesday, 16th.—Zoological, 9.
—— Civil Engineers, 8.
—— Royal Institution, 3. Charles Brooke, M.A., F.R.S., "On Force and Energy."
Wednesday, 17th.—Society of Arts, 8.
—— Pharmaceutical, 11. Annual Meeting.
Thursday, 18th.—Chemical, 8. R. J. Friswell, "On a New Double Salt of Thallium." Dr. Armstrong, "On a New Benzolic Derivative."
—— Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
Friday, 19th.—Royal Institution, 9. Professor Huxley, F.R.S., "On Bishop Berkeley and the Metaphysics of Sensation."
Saturday, 20th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."

TO CORRESPONDENTS.

P.—Consult the index.

The Chemist in the Studio.—This anonymous article is too much like a puff to be inserted in its present form.

Chemiker.—The Patent Office Library, Southampton Buildings, Chancery Lane; admission is free from 10 till 4 daily; you will find most of the works there.

Dr. Isidor Walz.—Received with thanks.

Just published, demy 8vo., 6s., by post 6s. 6d. (vol. i.),

Transactions of the Chemical Society of Newcastle-upon-Tyne.

Andrew Reid, Printing Court Buildings, Newcastle-on-Tyne.

Royal 8vo., pp. 388, price 7s. 6d. Third Edition.

The Patentee's Manual; being a Treatise on the Law and Practice of Letters Patent, especially intended for the use of Patentees and Inventors. By James Johnson, Barrister-at-Law; and J Henry Johnson, Assoc. Inst. C.E., Solicitor and Patent Agent.

The call for a Third Edition of this work is conclusive proof that it satisfies a want on the part of Patentees and Inventors, to whom a plain statement of the law bearing upon the subject of Letters Patent for Inventions is obviously a matter of great importance. Whilst the exposition of statutes and judicial decisions is expressed in plain and popular language, no sacrifice has been made of legal accuracy, and it will be found that the work contains a concise but ample and strictly correct enunciation of the law, with an examination of the decided cases to the latest date.

London: Longmans, Green, and Co.

Just published, price One shilling,

A Concise View of the Law connected with Letters Patent for Inventions. By James Johnson, of the Middle Temple, Barrister-at-Law, and J. Henry Johnson, Assoc. Inst. C.E., Solicitor and Patent Agent, Lincoln's Inn Fields and Glasgow. Authors of the "Patentees' Manual."

London: Longmans, Green and Co., Paternoster Row.

THE CHEMICAL NEWS.

Vol. XXIII. No. 599.

AN EXPERIMENTAL INQUIRY INTO THE CONSTITUTION OF BLOOD, AND THE NUTRITION OF MUSCULAR TISSUE.*

By WILLIAM MARCET, M.D., F.R.S.,
Senior Assistant Physician to the Hospital for Consumption and Diseases of the Chest, Brompton.

The results obtained from the inquiry which forms the subject of the paper are as follows:—

(1.) That blood is strictly a colloid fluid.

(2.) That although blood be strictly a colloid, it contains invariably a small proportion of diffusible constituents amounting to nearly 7·3 grms. in 1000 of blood, and 9·25 grms. in an equal volume of serum; these proportions diffusing out of blood in twenty-four hours.

(3.) That the proportion of chlorine contained in blood has a remarkable degree of fixity, and may be considered as amounting to 3 parts (the correct mean being 3·06) in 1000; the proportion of chlorine in a bulk of serum equal to that occupied by 1000 grms. of blood being 3·45, and therefore higher than in blood; and, moreover, that one of the objects of the chlorides, and other diffusible constituents of blood, appears to be to preserve the fluid state of the blood. The substances which yield an alkaline reaction to blood are crystalloid; their being retained in the blood while circulating through the body must be of the highest importance in connexion with the phenomena of oxidation constantly in progress during life.

(4.) That blood contains phosphoric anhydride and iron in a perfect colloid state, or quite undiffusible when submitted to dialysis, the relative proportions appearing to vary from 78·61 per cent of peroxide of iron and 29·39 of phosphoric anhydride, to 76·2 and 23·8 respectively; the proportion of phosphoric anhydride having a tendency to be rather higher.

(5.) That blood contains more phosphoric anhydride and potash, bulk for bulk, than serum. This fact has long been known; but I have shown that the excess of phosphoric anhydride and potash in the blood-corpuscles is greater than can be accounted for by the estimation of the proportions of colloid phosphoric anhydride and potash in blood and serum, consequently there exists in blood-corpuscles a power checking the diffusion of the diffusible substances they contain, and apparently connected with a force peculiar to the corpuscles, as this force ceases to act as soon as the corpuscular form disappears, from admixture with water. This property inherent to blood-corpuscles may cause an accumulation of potash in blood equal to no less than rather more than four times the amount of this substance present in an equal bulk of the serum of the same blood.

(6.) That a mixture of colloid phosphoric anhydride and potash can be prepared artificially by dialysis, and that the colloid mass thus obtained appears to retain the characters of the neutral tribasic phosphate from which it originates; it exhibits an alkaline reaction, yields a yellow precipitate with nitrate of silver, and after complete precipitation the reaction is acid.

(7.) That by dialysing certain proportions of phosphate of sodium and chloride of potassium during a certain time, proportions of phosphoric anhydride, potash, chlorine, and soda are obtained in the colloid fluid very similar to the proportions these same substances bear to each other in serum after twenty-four hours' dialysis.

(8.) That muscular tissue is formed of three different classes of substances; the first including those substances which constitute the tissue proper, or the portion of flesh insoluble in the preparation of the aqueous extract, and consisting of *albumen* and *phosphoric anhydride* with varying proportions of *potash* and *magnesia*; the second class including the same substances as are found in the tissue proper, and in the same proportions relatively to the albumen present in that class, but existing in solution and in the colloid state; the third class including the same substances as are found in the two others, and, moreover, a small quantity of chlorine and soda, which, although relatively minute, is never absent. The constituents of this class are crystalloid, and consequently diffusible, the phosphoric anhydride and potash being present precisely in the proportion required to form a neutral tribasic phosphate, or a pyrophosphate, as the formula $2KOPO_5$ can equally be $2KOHOPO_5$.

Class No. I. of the constituents of muscular tissue is to be considered as the tissue in the complete stage of assimilation.

Class No. II. constitutes the material from the blood on its way to form the Class No. I.

Class No. III. constitutes the material from Class No. I. in the *effete* state, and on its way out of flesh.

(9.) That flesh contains in store a supply of nourishment equal to about one-third more than its requirement for immediate use, this being apparently a provision of nature to allow of muscular exercise during prolonged fasting.

(10.) That the numbers representing the excess of phosphoric anhydride and potash in blood, over the proportion of these substances in an equal volume of serum in the regular normal nutrition of herbivorous animals, appear to bear to each other nearly the same relation as that which exists between the phosphoric anhydride and potash on their way out of muscular tissue, from which result I conclude that the blood-corpuscles have apparently the power of taking up and preparing the material which they themselves supply to muscular tissue for its nutrition.

(11.) That vegetables used as food for man and animals, such as flour, potato, and rice, transform phosphoric anhydride and potash from the crystalloid or diffusible into the colloid or undiffusible state; and it is only after having been thus prepared that these substances appear to be fit to become normal constituents of blood, and contribute to the nutrition of flesh.

A final remark, and one which is worth consideration, is the fact established by the whole of the present investigation, that there is a constant change, as rotation in nature from crystalloids to colloids, and from colloids to crystalloids.

The substances destined to nourish plants being inanimate must be diffusible, otherwise they could not be distributed throughout the mineral kingdom, and brought within the reach of plants. Vegetables transform into colloids the mineral substances destined to the food of animals, and it might be said that the locomotion of animals in some respects acts the same part as the diffusion of mineral substances; for animals move about in search of their colloid food, and crystalloid minerals are displaced by physical diffusion in search of the plants they are to nourish.

The excretory products of animals are crystalloid or diffusible, as far as these soluble constituents are concerned, the solid portions rapidly decomposing in contact of air and moisture into crystalloid compounds. Dead vegetable and animal tissue all return into crystalloids by decomposition, to be distributed afresh either by gaseous or liquid diffusion throughout the whole of the mineral world.

Hence Graham's great discovery of the laws of liquid and gaseous diffusion lifts up the curtain which veils the mysteries of animal life, and throws a flood of light on very many physiological phenomena which had until now remained in darkness.

* Abstract of a paper read before the Royal Society, May, 1871.

PRELIMINARY NOTICE ON THE

CHLORINE SUBSTITUTION COMPOUNDS OF THE ORCINS.

By JOHN STENHOUSE, LL.D., F.R.S., &c.

SCHUNCK, and subsequently the writer of this notice, many years ago studied the action of chlorine upon orcin, and obtained more or less crystalline products, contaminated with a brown resinous matter, from which, however, they did not succeed in separating the crystals in a state of purity. In the year 1864, De Luynes obtained a crystalline substance by acting on orcin with a mixture of potassium chlorate and hydrochloric acid; it had a melting-point of 159° C., and by analysis was found to have the composition of trichlor-orcin, $C_7H_5Cl_3O_2$.

Pentachlor-Orcin.—When a strong solution of orcin is added, with constant agitation, to a mixture of chlorine hydrate and water, care being taken to keep the latter in excess, the chlorine hydrate gradually disappears, and on standing the solution deposits a white crystalline substance, which is nearly pure pentachlor-orcin. In a pure state, it crystallises in large transparent lustrous prisms, which melt at 120·5°, and on analysis were found to have the composition $C_7H_3Cl_5O_2$; by long boiling with water they are decomposed. Aqueous solutions of the alkalies yield humus-like substances. I have also succeeded in isolating pentachlor-orcin from amongst the products of the action of potassium chlorate and hydrochloric acid on orcin.

Action of Hydriodic Acid on Pentachlor-Orcin.—When pure pentachlor-orcin is digested for a sufficient length of time with hydriodic acid and amorphous phosphorus, an oil is obtained which solidifies, on cooling, to a crystalline mass; this is very soluble in alcohol, and can thus be readily separated from the excess of amorphous phosphorus. On adding water to the alcoholic solution, a white precipitate is formed, which can be obtained in a pure state by one or two re-crystallisations from boiling water. It forms long colourless needles, which, on analysis, were found to have the composition $C_7H_5Cl_3O_2$, that of *terchlor-orcin*. They are not, however, identical with the substance described by De Luynes under that name, as they melt at 123°, whereas he gives 159° as the melting-point of his terchlor-orcin. The substance appears to have feeble acid properties, being soluble in dilute alkalies and re-precipitated by acids.

Action of Calcium Hypochlorite on Orcin.—When a solution of orcin in hydrochloric acid is gradually added to a somewhat dilute solution of calcium hypochlorite, a considerable amount of chlorine is evolved, and the solution becomes turbid. After some time, a crystalline substance is deposited, which, when purified and subjected to analysis, was found to have the composition—

$$C_7H_3Cl_5O_2,HClO.$$

I propose for this substance the provisional name of *pentachlor-orcin hypochlorite*. When pure it forms large prismatic crystals, which melt at 140·5°.

Action of Chlorine on Resorcin, Pentachlor-Resorein.—The action of chlorine hydrate on resorcin does not yield by any means satisfactory results, the products being oily and uncrystallisable. I have, however, succeeded in isolating, from amongst the products of the action of potassium chlorate and hydrochloric acid on resorcin, a crystalline substance which, when purified, forms large colourless prisms very closely resembling pentachlor-orcin. They melt at 92·5°, and the analysis corresponds to the formula C_6HCl_5O. The action of hydriodic acid on pentachlor-resorcin yields a crystalline substance, which appears to be terchlor-resorcin.

I am at present engaged in more fully investigating the compounds above mentioned, and also some of their derivatives, which, from preliminary experiments I have made, appear to be very interesting.

ON THE

MOLYBDATES AND VANADATES OF LEAD, AND ON A NEW MINERAL FROM LEADHILLS.*

By Professor Dr. ALBERT SCHRAUF, of Vienna.

IN 1825,† Professor Wöhler published the analysis of a rare variety of pyromorphite from Leadhills, which he describes as an aggregation of very diminutive, orange-red hexagonal crystals, fixed on cerussite. The normal constituents of pyromorphite are mixed in them with small quantities of iron and arsenic. Professor Wöhler having ascertained the existence of vanadine-lead only five years later (1830), and the presence of partly chromium, partly vanadium in Russian specimens of pyromorphite having been stated, it may be supposed that the red pyromorphite from Leadhills owes its characteristic colouration to one or both the elements named before.

An examination of a great number of cabinet specimens from Leadhills gave no satisfying result. I could not find any red pyromorphite, as described by Professor Wöhler, on the specimens at my disposal, and must, consequently, leave unproved the above-stated supposition concerning the colouring substance of red pyromorphite. A cabinet specimen, dating from the years 1820-1825, gave me, however, the proof that the specimens of cerussite found at Leadhills during this period were not completely free from an admixture of molybdenum and vanadium. I succeeded in finding out a specimen of crystallised "vanadine-molybdate of lead" from Leadhills so strikingly different by crystallographical and chemical characters from its next allies, Wulfenite and Descloizite, that it authorises me to consider it as the type of a new species, for which I propose the name of "Eosite," alluding to its saturate aurora-red colour.

1. *Paragenetic Relations of Eosite.*

The cabinet specimen on which I have found the crystals of eosite is in possession of the Imperial Museum since 1828; it must, therefore, as remarked above, date from the years between 1820 and 1825. Its matrix, abundantly beset with crystals of cerussite, is cellular, ochreous galena. The crystals of cerussite, about 3—8 m.m. in size, bear the aspect of plates, and are greenish yellow; some of them completely fill up a deep cavity in the ochreous matrix, others are scattered on the surface of the specimen. This cerussite, as also some places of the matrix, is in several points covered with small moss-like aggregations of delicate and minute acicular yellow crystals. If such a fascicular aggregation is detached, and the concentrically grouped acicular crystals taken away, their nucleus is found to be a very small red crystal fixed on cerussite. When examined with a powerfully magnifying loupe, the specimen shows about twenty such minute red crystals, more or less scattered over the surface of the cerussite, wrapped up, some of them entirely, others only by half, into the above-described fine yellow acicular crystals. As to be subsequently proved by precise determination, the minute red octahedra are eosite, and the yellow acicular crystals are pyromorphite.

These last crystals, being only ¼—1 m.m. in length and about 1-10th m.m. in thickness, could only be determined by the aid of the microscope.

They are yellow, pellucid or transparent, very brilliant, with light yellow streaks. The microscope shows prismatical planes without any distinguishable terminal planes. As previously for my investigations on labradorite, I used for the measurement of the angles of the prismatical planes a vertical circle adapted above the horizontal table of the microscope, whose axis bears the object to be measured beneath the microscope's focus; the crystal fixed to the

* Abstract of a paper read before the Royal Society, May, 1871. Translated by Count A. Fr. Marschall.

† *Poggendorff's Annalen*, vol. iv., p. 169.

axis being duly adjusted and centred, the proceedings go on as usual. Two acicular crystals, duly adjusted, gave as results:—

0°,
60°,
120°,
180°,

from which the planes, including them, must be admitted to be those of a regular hexagonal prism.

Their colour, and even their streak, being light yellow, they may be either mimesite or pyromorphite on vanadate of lead. A drop of chlorhydric acid poured on such a crystal makes its tint vanish gradually without bringing to appearance a dark brown nucleus (as is the case with vanadite of lead), and finally produces a pseudomorph of white chloruret of lead. By heating on charcoal a brown globe with facetted surfaces traces of lead are obtained; the smell of arsenic is very insignificant. Smelting with bisulphate of potash in a platinum spoon gives merely a portion of white saline substance. All these tests were indicative of pyromorphite without any admixture of vanadium; the quantities submitted to operation being, however, very minute, a definitive judgment is not to be pronounced.

2. *Chemical Characters of Eosite.*

The crystals of this mineral are all below ½ m.m. in size, and difficult to be made free from the acicular pyromorphite covering them. They are easily detached from the cerussite, on whose surface they are fixed. Their hardness falls between 3 and 4 (Mohs's scale). When compressed, they are crushed into small, irregular granules, showing slight traces of cleavage.

The colour of the eosite is a saturate aurora-red, even deeper than that of the chromate of lead and approaching the tint of red sulphuretted arsenic; the red tint of the urefinite from Ruskberg (Banat) is less intense, that of the Phenixville specimens has more of yellow in it; the tints of Dechenite and Descloizite are varying between brownish carnation and greenish-brown.

The powder resulting from the friction on a hard surface is brownish-orange in eosite, somewhat darker than that from red chromate of lead.

As the powder from red chromate of lead or of red Wulfenite, that from eosite loses its colour and becomes white by contact with chlorhydric acid. This solution, diluted and spread over a glass plate, shows under the microscope the formation of chloruret of lead in white acicular crystals. A minute splinter of eosite, when put on a glass plate and a drop of cold chlorhydric acid poured on it, undergoes, within a quarter of an hour, a partial solution along its margins, pseudomorphising into white chloruret of lead, the interior still remaining partly unaltered. The solution in chlorhydric acid is slightly tinted with yellow; red chromate of lead or vanadinite are more easily solved, and the tints of their solutions are more intense. Wulfenite, even when used in fragments, ten times larger, loses its colour, and becomes white in far shorter time.

If a splinter of eosite is solved in a drop of slightly heated chlorhydric acid, the solution spread on a glass plate, some alcohol added to it, and the whole again heated to evaporation,* a bluish deposit, somewhat verging into greenish-grey, is obtained. With respect to the quantity of eosite experimented upon, and to the extent of the deposit, its tint may be considered as middle-intense; it is bordered on its margin by a delicate green, somewhat acicular precipitate. Fragments of yellow Wulfenite, vanadinite, or red chromate of lead, of equal size and treated in the same way, give different deposits on the glass plate; Wulfenite, a deep blue one (on account of the formation of molybdate of molybdene), vanadinite, a yellowish or bluish-green one, and crocoïte, a feeble yellowish-green one†. The crystals of eosite being of scarce occurrence and of diminutive size, only few experiments could be made concerning the action of the blowpipe on them.

Eosite, when heated in a glass recipient, assumes a darker tint without decrepitating, and, when cooled, takes again its original colour. A splinter of this mineral mixed with three times its volume of bisulphate of potash and smelted on a platinum lamina, gives, under a glowing heat, a transparent, nearly uncoloured saline mass with a very slight light yellow tint. During its cooling, this mass becomes for a moment reddish brown, and, after complete cooling, assumes a light orange-brown tint.

Comparative experiments made with chromate, vanadate, and molybdate of lead, as also with binary mixtures of the powders of these three substances, proved the colour of the eosite salt to approach very nearly the tint of the saline mass obtained by smelting a mixture of two to three parts of molybdate of lead, and one part of vanadate of lead with bisulphate of potash.

The substance obtained by smelting eosite with bisulphate of potash, brought into contact with water in a platinum spoon, gives a solution which, some tinfoil being added to it and the whole being brought to ebullition‡, assumes a faint greenish-blue tint. A second experiment gave the same result, and proved the solution to give, when further evaporated, a yellowish-brown residuum—possibly caused by the presence of vanadium. Wulfenite, treated in the same way, gave a deep blue tint, vanadinite a light yellowish green, and chromate of lead a light yellowish grey of the saline solution heated in contact with tinfoil.

It would be desirable to ascertain experimentally the presence of other metals besides lead, were not the scarcity of the material an obstacle to any further experiments besides those of absolute necessity.

Considering the whole of the experiments above described, the way in which eosite is acted upon by heating in a glass recipient by chlorhydric acid, alcohol, and bisulphate of potash, proves this mineral to be essentially a vanado-molybdate of lead; possibly with an excess of molybdenum, as it may be supposed from the colourations caused by chemical action, the presence of an undoubtedly minute quantity of chrome being concealed by the chemical action of the prevalent constituents.§

The investigations here detailed, having ascertained the presence of lead, molybdenum, and vanadic acid in eosite, it is still to be proved that the chemical actions of vanadate and molybdate of lead are essentially different from those manifested by eosite, and that consequently this mineral is to be identified neither with the red varieties of Wulfenite actually known, nor with the crystals of Dechenite, vanadite, or Descloizite.

3. *Chemical Properties of the Chromo-Wulfenites.*

The late Professor H. Rose (*Poggendorff's Annalen*, vol. xlvi., p. 639) is known to have investigated the red varieties of Wulfenite from Rézbánya, (Banat), and Siberia, and to have ascertained the presence of chrome in them. I have before me cabinet specimens from Rézbánya, Ruskberg (Banat), and Phenixville, which I shall comprehend here under the general denomination of "Chromo-Wulfenites." The specimens from Rézbánya being rather yellowish than pure red, I must confine my investigations to those from Ruskberg and Phenixville.

* It must be remarked that all these experiments have been made under the microscope, or, at least, under a powerful magnifying lens, so that it was impossible to separate the chloride of lead from the solution containing molybdene.

* As M. Gudowicz has stated (*Poggendorff's Annalen*, vol. cxx., p. 17), the action of alcohol on the chlorhydric solution of vanadine gives rise to precipitates, tinted between blue or brown, according to the degree of oxidation. I also obtained at first, by mixing with alcohol a solution of vanadate of lead, precipitates changing from yellowish green into brown, according to the degree of heat. The exact and constant temperature for the evaporation of alcohol was, however, soon ascertained by a series of experiments.

† The splinters of eosite submitted to chemical action being scarcely ½ m.m. in size, the chloruret of lead could not be isolated.

‡ The existence of vanadium, as accidentally entering into the composition of the *genuine* Wulfenites, has been ascertained by Professor Wühler on occasion of his experiments concerning the production of molybdic acid by the treatment of Wulfenites (see Liebig and Kopp, *Ann. d. Chem. und Pharm.*, vol cii., p. 383.

The matrix of the Ruskberg pyromyrphite* is cellular quartz and galena. A good number of rather bright, deep-red octahedral crystals of Wulfenite, 1—2 m.m. in size, are fixed at the surface of the pyromorphite.

The crystals of Phenixville are notably larger (2—4 m.m.), and concreted into a crust on the surface of the matrix (quartz and pyromorphite). Although apparently of even surface, these crystals show merely a peculiar wax-like brightness.

The red of eosite is more saturated than that of krocoïte; it is somewhat more intense than that of the Ruskberg chromo-Wulfenite, and less mixed with yellow than in the Phenixville specimens. The streak is more brownish in eosite than in chromate of lead. The streaks of the Ruskberg crystals and of those from Berezowsk are quite identical; the powder of the Phenixville crystals is light orange, verging into sulphur-yellow.

The Ruskberg and Phenixville chromo-Wulfenites, treated with chlorhydric acid in the way above described, leave both a deep blue precipitate with a yellowish-green margin. Smelted with bisulphide of potash in a platinum spoon, they give both a saline compound, becoming very faintly yellowish-green after cooling. In the beginning of fusion a brownish purple tint appeared, especially on the Phenixville crystals. This circumstance, not remarked on eosite or vanadate of lead, confirms the fact ascertained by Professor Rose, of chrome being a prevailing component of the red Wulfenites of Banat, with which, according to my observations, I rank also the yelowish-red Wulfenites from Phenixville. According to Mr. Smith, these last contain vanadium; however, the specimen before me, when smelted with bisulphate of potash, had certainly manifested the presence of this metal, were it a prevailing constituent, as chrome really is. At all events, the red Wulfenites may possibly contain a certain proportion of vanadium, as may be expected as to nearly all Wulfenites in consequence of Professor Wöhler's statements.

(To be continued).

ON THE

REDUCTION OF CERTAIN METALS FROM THEIR SOLUTION BY METALLIC SULPHIDES,

AND THE RELATION OF THIS TO THE

OCCURRENCE OF SUCH METALS IN A NATIVE STATE.†

By WILLIAM SKEY,
Analyst to the Geological Survey of New Zealand.

In a paper read by Mr. C. Wilkinson, before the Royal Society of Victoria, "On the Formation of Gold Nuggets," publicity is given to the fact, first observed by Mr. Daintree, that gold, when placed in a solution of its chloride undergoing decomposition by contact with organic matter, determines the deposit of much or all the liberated gold upon itself.

In the same paper, the author states that he finds copper, iron, and arsenical pyrites, galena, zinc blende, stibnite, wolfram, and molybdenite also act as nuclei for gold thus reduced, but that brown iron ore and quartz do not.

The general correctness of these statements has been verified by the results of a critical enquiry, conducted by Mr. Cosmo Newberry, Analyst to the Geological Survey of Victoria; but I notice there has not been any attempt on the part of either of these authors to explain these very singular phenomena.

That gold itself should be nuclear to gold slowly precipitating from its solution is by no means abnormal or unrelated to other phenomena; it is, in fact, just what we should expect from a consideration of the mode of deposit of numerous other substances from their solutions. Whether such deposits are crystalline or amorphous, they generally tend to arrange themselves round a nucleus of their own substance; but, that substances so chemically dissimilar as those specified by Mr. Wilkinson, both as compared among themselves and to gold, should also be nuclear under these circumstances, appeared altogether so strange and anomalous, that I was induced to make further researches into this subject, for the purpose of ascertaining what other substances (if any) could be added to this list of nuclei rendered, and whether any of them could be nuclear for other metals during their slow precipitation, so that from an enquiry thus extended some general principle might be discovered regulating and explaining such deposits.

The results of these I now beg to lay before this Society. They have been so singular and unexpected, and have taken a direction so different to that contemplated for them, that I have had to change the title of this paper, as first adopted and worked to, into the one now assigned to it.

I found, in the first place, on repeating the experiment adverted to, with certain modifications, that in the case of wolfram the tendency of gold to deposit thereon might properly be referred to the well-known reducing power of soluble proto-salts of iron upon salts of gold, since protoqxide of iron forms a considerable portion of this mineral, and is actually dissolved away from it to a small extent by dilute acids at common temperatures—at least I found it so in the case of a specimen of it I had from the Museum here. The case, therefore, so far as these results of Mr. Wilkinson's are concerned, is reduced to one in which there only remains to consider the metallic sulphides and arsenides, a set of metals both chemically and mineralogically related to each other.

Now, in respect to these sulphides, it is distinctly stated in Mr. Newberry's paper that, in even "weak solutions" of terchloride of gold (the salt used in his experiments), "they decompose, but so slowly as not to interfere with the deposit taking place regularly." Having corroborated the correctness of this statement, and also proved that the arsenides are similarly affected, it occurred to me that (though hitherto quite unsuspected) this decomposition was very intimately connected with the first deposit of gold upon these sulphides: that, in reality, the commencement of metallic deposit was effected, not by the interaction of organic matter, as supposed, but by that of the several nuclei themselves with the salt of gold.

I therefore agitated a little finely-powdered galena (sulphide of lead) with a weak solution of terchloride of gold, omitting the addition of organic matter, and taking every precaution against its presence accidentally, when I found, after a little while, the gold solution had become quite colourless, and on testing it not a trace of this metal could be found. It had evidently been absorbed, as it were, by the galena; and, in fact, a careful inspection of this mineral showed it to be feebly gilded.

Small cubes of galena, simply immersed for a few hours in a strong solution of the gold salt without organic matter, were so thoroughly gilded over the greater part of their surfaces that in certain positions they could not be distinguished from gold by the eye.

Chloride of gold was also found to be reduced by contact with the following sulphides (they include, as will be observed, all those mentioned by Mr. Wilkinson):—Sulphides of iron (proto- and bi-sulphide); sulphides of copper (ferro-sulphide and sub-sulphide); the sulphides of zinc, tin, molybdenum, lead, mercury, silver, antimony, bismuth, arsenic, platinum, and gold; and among the arsenides, mispickel and arsenide of silver. Cubical iron pyrites is rather slow in its action upon this solution of gold, while sulphide of antimony scarcely affects it at first, but after some hours' contact with it, reduction goes on rapidly, perhaps by aid of some galvanic action. All these

* Ruskberg lies in Austrian Banat, next to the threefold frontier between Banat, Transsylvania, and Wallachia.

† Read before the Wellington Philosophical Society.

effects were produced at common temperatures, with the exception of sulphide of bismuth, while other experiments with iron and copper pyrites prove similar effects are produced when all kind of light is excluded, so there is no reason to suppose that light has been concerned in any of these reactions.

I should state that, in the case of some of the highly-coloured minerals, such as cinnabar and arsenide of silver, for instance, it is necessary to operate upon their streak in order to obtain a visible deposit upon them at common temperatures within a reasonable time. With hot solutions, however, even these are well gilded in an hour or two.

A portion of the metal of the sulphide was uniformly found in the solution afterwards, and also sulphuric acid; the mode, therefore, in which these effects were produced was evidently by the oxidation of both the constituents of the nucleus employed.

Thus we have removed this singular anomaly of gold in the act of precipitating, selecting as nuclei substances so diverse as those cited, and while refusing others, which, in reality, differ no more from such non-metallic nuclei than do these from gold; as it certainly appears from these results that, whatever gold has been reduced by organic matter in the experiments quoted, would never deposit on these non-metallic nuclei *surface to surface*, but only upon *gold* already occupying such surfaces, reduced by the exercise of affinities far superior and swifter in their action than those involved in the decay of wood or other organic structures employed by Mr. Wilkinson in the experiments I have alluded to. Being so, therefore, the question next arose—Is organic matter, unnecessary as it certainly is for the commencement of gold deposits on these nuclei, is it necessary to continue them, and to give them that close coherent form obtained when such matters were administered?

Experimentally, it appeared quite unnecessary for this, too, as it was found that the solution, after depositing a certain time, often gave films towards the angles of the nuclei, which were of some thickness, and which under the microscope appeared quite continuous.

The reducing effects of metallic sulphides and arsenides upon salts of gold being thus manifested, it became of some interest to enquire whether or no any other metallic salts were capable of being reduced by these substances.

This part of the subject I have only slightly investigated, but enough has been discovered to show that silver and platinum, and possibly most or all the metals of the platinum series, are reducible in this way from their solutions in acids.

Thus silver is reduced from either its nitrate or acetate very readily by galena, copper pyrites, and the inferior sulphides of iron and copper. From ammoniacal solutions, however, it is not reduced by any of these sulphides, not even when heated with them, excepting by sub-sulphide of copper.

As precipitated by galena, the silver selects some angular portion of it to deposit on, and sometimes strikes off from this in beautiful arborescent form and minutely crystalline filaments, exactly like those which the metal generally assumes in its native state.

Cubic iron pyrites, also stibnite, has little or no effect upon silver salts, not even when heated with them; arsenide of silver has, however, a feeble effect.

The metal platinum is very slowly removed from its bichloride solution by galena and grey copper ore; also by iron pyrites, but at a still slower speed. These were the only sulphides tried.

Mercury does not appear to be reduced to the metallic state by any of the sulphides enumerated from its bichloride solution, but most of them reduce it to the subchloride. Sulphide of gold even thus affects this mercurial salt, the sulphur being oxidised and the gold set free.

Neither the sulphate nor the acetate of copper are affected by these sulphides; but perchloride of iron is reduced to the protochloride by galena and grey copper ore.

Before I proceed to the next part of the subject, I had better state here the results I obtained when other gold solutions were administered to these sulphides, the one hitherto employed in the experiments described being, as will be remembered, the chloride.

When, in the place of this salt, I applied the *oxide* (of gold) in solution of either potash, bicarbonate of soda, or an alkaline silicate, the same reduction of the metal followed—at least, this was the case for galena and the inferior sulphides of iron and copper. If the oxide is dissolved in ammonia, such results require for their production an elevation of the temperature of the solution to about 200° F.

In the case of the sulphide of gold, however, whether dissolved in any of these salts or alkalies, it was found this compound could not be reduced by contact with any of these sulphides, either at common temperatures or at the boiling-point of the particular solution employed, nor yet when strong deoxidising agents, such as tannic or gallic acids, were used along with such gold solutions.

All this tends to show, I think, that in the case where Mr. Newberry obtained the reduction of gold upon iron pyrites from a solution of its sulphide in bicarbonate of soda mixed with organic matter, the gold had, prior to the act of reduction, become in some way divested of its sulphur, and had taken up oxygen in exchange, thus passing to a salt readily reducible by deoxidising agents.

During the period of time which had to be allowed by Mr. Newberry for his experiment the oxygen of the air might have oxidised the sulphur of the auriferous sulphide, as it does that of several other metallic sulphides, and so rendered him a gold compound amenable to the influence of deoxidising substances; any way, it is inconceivable how organic matter and metallic sulphides, singly or conjointly, can desulphurise a gold sulphide. The effect of organic matter in a state of decay is rather to generate sulphides than to decompose them, thus retarding in the place of promoting the reduction of such compounds of gold. It is hard to suppose there could have been any chemical interchange effected by the mere addition of bicarbonate of soda to the gold sulphide, since gold has far more affinity for sulphur than for oxygen—it could hardly pass to an oxy-salt, therefore, in this manner; besides, if it could, then reduction should have proceeded as well with this kind of solution as with the gold oxide in solution of bicarbonate of soda, which, as before stated, I found it did not.

Further experiments in this direction are, however, absolutely necessitated by the importance of ascertaining positively whether there is any solution of gold (likely to occur naturally) able to resist the reducing power of either metallic sulphides or organic matter in a state of decay.

The several results arrived at in these investigations are now stated; it only remains, therefore, to point out, or, rather, to refer, to the very obvious relation they appear to sustain to the manner in which certain of our native metals are frequently associated.

The great deoxidising power of sulphides generally upon most gold, silver, and platinum salts, as manifested by the experiments just described, renders them so absorbent, as it were, of these metals, that any such solutions traversing a very thin vein even or reef of the mixed metallic sulphides would, in all probability, be completely divested of these metals.

Solutions of silver, however, would be little, if any, affected in traversing a reef of either iron pyrites or stibnite; but if, in addition to silver, the solution contained gold, it is very probable a certain portion of the silver would precipitate along with the gold as the result of a secondary action, that is, by a simple chemical substitution. On the other hand, silver would readily be absorbed by veins of galena or inferior sulphides.

All this certainly agrees very well with what we find on examination of these sulphides; indeed, the facts just

stated seem to explain very simply the constant or the frequent association of gold and silver with certain of our metallic sulphides, and their absence or comparative scarcity in others. Whether or no this is the reason of such association, the knowledge that certain metallic sulphides and arsenides are capable of reducing these metals from their solutions should, I think, be taken into careful consideration when we attempt to explain the origin of these metals in the forms they have taken and in the rocks or veins they have selected.

As yet, every theory of any general acceptance which has been broached to explain the occurrence of such metallic deposits in these matrices is based upon the reducing action of organic matter, when the fact is that most of the common sulphides are much superior in this respect to such matters, being far more rapid in their effects, and capable of reducing, weight for weight, more metal—a single grain of iron pyrites being sufficient to reduce 8½ grains of gold.

While, therefore, allowing that organic matter has had a share in the reduction of gold and other metals, I cannot but think that by far the greater portion of our gold and silver deposits, especially those situated in the deeper-seated rocks and lodes removed from carboniferous strata, have been wholly due to the deoxidising effects of pyritous minerals.

Of course both theories require, as a common ground, that the metal shall first be in such a state of combination as to be soluble in water, a condition which is generally conceded to it, and which I have, therefore, taken all along as actually obtaining.

I cannot take leave of this subject without adverting to and commenting upon some of the singular chemical reactions which these researches have opened upon.

In the first place, it has appeared that aqueous solutions of oxy-salts of gold, among which we must include the chlorides, for obvious reasons, possess oxidising power to an extent not hitherto contemplated for them, great as this may have been acknowledged. I think it is a little superior to that of chromic acid, since it attacks cubical pyrites pretty readily in the cold, while chromic acid scarcely affects it.

Further, these salts of gold not only oxidise the metals of these sulphides, but their sulphur too, although I find, from direct experiment, neither common (sublimed) sulphur, nor yet sulphur precipitated from solution in alkalies are the least affected by them, not even when these auriferous solutions are raised to their boiling-points.*

This vulnerability of combined sulphur, as against the invulnerability of the same substance when free, suggests the greatness of the change which sulphur in itself undergoes when it passes to a state of combination.

Possibly some voltaic action facilitating this change may be set up by these several substances among themselves, in which the gold already reduced would form the negative element, but this does not, of course, explain how the oxidation commenced.

DETERMINATION OF ALKALIES IN MINERALS, &c., BY IGNITION WITH CARBONATE OF LIME AND SAL-AMMONIAC.†

By J. LAWRENCE SMITH.

(Concluded from page 223.)

12. *Method of Analysis.*—We have now the pure carbonate of lime, granular sal-ammoniac, and the proper crucible. The silicate is to be well pulverised in an agate mortar;‡ for the analysis I take ½ grm. or 1 grm., the former is most commonly used, as being sufficient, and best manipulated in the crucible used; a gramme, however, may be conveniently employed. The weighed mineral is placed in a large agate mortar, or better in a glazed porcelain mortar, of ½ to 1 pint capacity. Weigh out an equal quantity of the granular sal-ammoniac (a centigramme more or less is of no consequence), put it in the mortar with the mineral, rub the two together intimately; after which add eight parts of carbonate of lime in three or four portions, and mix intimately after each addition; empty the contents of the mortar completely upon a piece of glazed paper, that ought always to be under the mortar, and introduce into the crucible. The crucible is tapped gently upon the table and the contents settled down.

13. It is then clasped by a metallic clamp in an inclined position, or it is placed in the support referred to in the latter part of this article, leaving outside about ¼ or ¾-inch; a small Bunsen burner is now placed beneath the crucible, and the heat brought to bear just about the top of the mixture, and gradually carried toward the lower part, until the sal-ammoniac is completely decomposed, which takes place about four or five minutes; heat is then applied in the manner suggested, either with the blast or with the burners referred to, acting by its own draught, and the whole kept up to a bright red heat, for about from forty to sixty minutes. It is well to avoid too intense a heat, as it may vitrify the mass too much.

14. The crucible is now allowed to cool, and, when cold, the contents will be found to be more or less agglomerated in the form of a semi-fused mass; a glass rod or blunt steel point will most commonly detach the mass, which is to be dropped into a platinum or porcelain capsule of about 150 c.c. capacity and 60 or 80 c.c. of distilled water is added. In the course of a longer or shorter space of time, the mass will slake and crumble after the manner of lime; still better, this may be hastened by bringing the contents of the capsule to the boiling-point, either over a lamp or water-bath. At the same time, water is put into the crucible to slake out any small particles that may adhere to it, and subsequently this is added to that in the capsule, *washing off the cover of the crucible also.*

15. After the mass is completely slaked, the analysis may be proceeded with, although, as a general thing, I prefer to allow the digestion to continue six or eight hours, which, however, is not necessary. If the contents of the crucible are not easily detached, do not use unnecessary force, as the crucible may be injured by it, but fill the crucible to about two-thirds of its capacity with water, bring almost to the boiling-point, and lay it in the capsule, with the upper portion resting on the edge; the lime will slake in the crucible, and then may be washed thoroughly into the dish, and, as before, the cover is to be washed off.

16. We have now by this treatment with water the excess of lime slaked into a hydrate, and some of the lime combined with the silica and other ingredients of the silicate, in an impalpable form; in solution there is the excess of the chloride of calcium formed in the operation, and all the alkalies originally contained in the mineral as chlorides, and all that now remains to be done is to filter, separate the lime as carbonate, and we have nothing left but the chlorides of the alkalies. To do this, I proceed as follows:—

17. Throw the contents of the capsule on a filter (the size preferred for the quantity above specified is one 3 to 3½ inches in diameter), wash well, to do which requires about 200 c.c. of water; the washing is executed rapidly. The contents of the filter (except in those cases where the amount of the mineral is very small, and there is no more for the estimation of the other constituents) is of no use, unless it be desired to heat again, first adding a little sal-ammoniac to see if any alkali still remains in it, a precaution I find unnecessary. The filtrate contains in solu-

* Chromic acid and *cold* nitric acid have the same effect upon sulphide of gold, but have none upon these forms of sulphur.

† From "Select Methods in Chemical Analysis," by W. Crookes, F.R.S., &c. London: Longmans.

‡ While in all mineral analyses thorough pulverisation of the mineral is usually essential, still it is a singular fact that very good analyses can be made with this method, even when the powder is tolerably coarse, and in some experiments with lepidolite, powder was used with much of it in particles from 1-40th to 1-30th of an inch in size, giving good results. Notwithstanding this, thorough trituration of the mineral is recommended.

tion all the alkalies of the mineral, together with some chloride of calcium and caustic lime; to this solution, after it has been placed in a platinum or porcelain capsule is added a solution of pure carbonate of ammonia; (equal to about 1½ grms. is required).

18. This precipitates all the lime as carbonate; it is not, however, filtered immediately, but is evaporated over a water-bath to about 40 c.c., and to this we add again a little carbonate of ammonia and a few drops of caustic ammonia to precipitate a little lime that is re-dissolved by the action of the sal-ammoniac on the carbonate of lime. Filter on a small filter (2 inches), which is readily and thoroughly washed with but a little water, and the filtrate allowed to run into a small beaker glass. In this filtrate are all the alkalies as chlorides and a little sal-ammoniac; add a drop of a solution of carbonate of ammonia, to make sure that no lime is present. Evaporate over a water-bath in a tared platinum dish, in which the alkalies are to be weighed; the capsule used is about from 30 to 60 c.c. capacity, and during the evaporation is never filled to more than two-thirds its capacity.

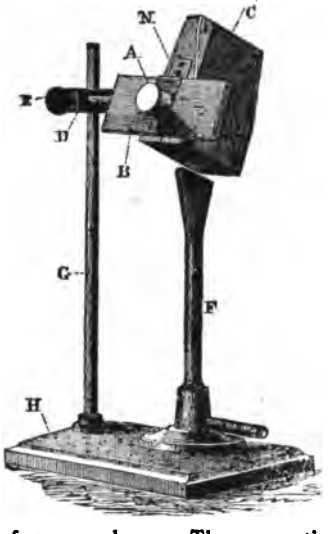
19. After the filtrate has been evaporated over the water-bath to dryness, the bottom of the dish is dried, and on a proper support heated *very gently* by a Bunsen flame to drive off the little sal-ammoniac. It is well to cover the capsule with a piece of thin platinum to prevent any possible loss by the spitting of the salt after the sal-ammoniac has been driven off. Gradually increasing the heat, the temperature of the dish is brought up to a point a little below redness, the cover being off (the cover can be cleansed from any sal-ammoniac that may have condensed by heating it over the lamp). The capsule is again covered, and, when sufficiently cooled, before becoming fully cold, is placed on the balance and weighed. This weight gives as chlorides the amount of alkalies contained in the mineral.

20. If chloride of lithium be present, it is necessary to weigh quickly, for this salt being very deliquescent attracts moisture rapidly.

It not unfrequently occurs that the chlorides at the end of the analysis are more or less coloured with a small amount of carbon, arising from certain constituents in carbonate of ammonia; the quantity is usually very minute, and in no way affects the accuracy of the analysis. In selecting pure carbonate of ammonia for analytical purposes, it is well to select specimens that are not coloured by the action of the light.

21. It only now remains to separate the alkali by the known methods. Under this head I have made several observations that will be published as soon as they are considered satisfactory.

22. *A Special Arrangement for Heating the Crucibles by Gas.*—The support and burner, where gas is to be had (as it is in almost all analytical laboratories) are simple in their character, and have been arrived at after a great variety of experiments with gas furnaces. The figure here given illustrates the stand, burner, crucible, &c.,* and is about one-sixth the natural size. H is the stand with its rod, G. D is a brass clamp, with two holes at right angle to each other; having two binding screws, it slides on the rod, G; the second hole is for a round arm attached to B, the binding screw, E, fixing it in any position. B is a plate of cast-iron, 5 to 6 m.m. thick, 10 to 11 centims. long, and 4½ centims. broad, having a hole in its centre large enough to admit the crucible to within about 15 m.m. of the cover without binding. A is the crucible already referred to, which is made to incline a few degrees downwards, by turning the plate of iron that supports it. C is a chimney of sheet-iron, 8 to 9 centims. long, 10 centims. high, the width at the bottom being about 4 centims. at one end, and about 3 centims. at the other end. It is made with the sides straight for about 4 centims., then inclines towards the top, so as leave the width of the opening at the top about 1 centim. A piece is cut out of the front of the chimney of the width of the diameter of the hole in the iron support, and about 4 centims. in length, being semicircular at the top, fitting over the platinum crucible. Just above this part of the chimney is rivetted a piece of sheet-iron in the form of a flattened hook, N, which holds the chimney in place by being slipped over the top of the crucible support; it serves as a protection to the crucible against the cooling effects of the currents of air. F is the burner, which has been described in an article on flame heat in the *American Journal of Science*, November, 1870, p. 341, the upper opening of which is a slit from 1½ to 2 m.m. in width, and from 3 to 4 centims. long, and when used is brought within about 2 centims. of the lowest point of the crucible, the end of the flame just playing around the lower end of the crucible. The gas enters the lower part of the burner by two small holes of 1-16th of an inch, furnishing at 1-inch pressure about 5½



cubic feet of gas per hour. The precaution must be observed, already referred to, in heating the crucible a first gently (13).

23. It is surprising to see the effect produced by this simple burner as here used; 8 grms. of precipitated carbonate of lime can be decomposed to within 2 or 3 per cent in one hour, and when mixed with silica or a silicate, in a very much shorter space of time, although in my analyses I employ one hour, as it requires no attention after the operation is once started. This form of furnace and crucible is found to be convenient for other operations.

24. Although the details given here are lengthy, the time occupied in the analysis is short and the precautions necessary are of a simple character, so much so that results obtained by students on beginning chemical analysis have been found by me reliable, and less variable on the alkalies of the silicates than of any of the other constituents of this class of bodies. I have often made good alkali determinations in three hours from the commencemnt of the operations, hastening the evaporations by more direct application of heat, which of course, requires close watching.

25. It is a common practice, when a silicate comes under my examination that it is not easily made out by its physical properties, to make at once an alkali determination, which often indicates at once what it is if it be a known silicate. If not, the alkali determination serves as one step in its examination.

* These burners and stands, as well as the platinum crucibles, made according to Professor Lawrence Smith's pattern, can be obtained of Messrs. Johnson and Matthey, Hatton Garden.

St. Mary's Hospital.—We are glad to learn that Dr. C. R. A. Wright has been appointed Lecturer on Chemistry and Practical Chemistry *vice* Dr. Russell, who is now the Professor of Chemistry at St. Bartholomew's Hospital.

ON SOME OF THE

CONDITIONS OF LOSS BY VOLATILISATION IN CERTAIN METALLURGICAL OPERATIONS.*

By CHARLES P. WILLIAMS,
Professor of Chemistry, &c., Delaware College.

IT is a well recognised fact, pointed out by an expensive experience, that in all methods of lead smelting and in oxidising and chloridising roastings generally, a very considerable loss of metals results. This loss is brought about either by the formation of more or less volatile compounds, or by the draught of the furnace carrying, mechanically suspended, particles of chemically changed ore, with the products of combustion, or, in the case of muffle furnaces, with the atmosphere sweeping over the ore therein treated. The problem of devising an economical and complete method of collecting these metallic vapours or fumes is one of very considerable difficulty, and it may be fairly questioned if it has yet received a satisfactory solution. In this country, where rich lead ores are abundant, and where all the elements, except labour, entering into the metallurgical treatment of such ores are comparatively cheap; this matter of condensation and collection has not generally forced itself upon the attention of practical metallurgists, but it is, nevertheless, of considerable significance.

In the treatment of silver-bearing ores by smelting operations, or where a previous chloridising roasting is necessary, the loss of silver by volatilisation must be of significant importance, and will yet, if it has not already, give rise to a study of the means adapted to its prevention. Various European experimenters have given different figures for the loss of silver by volatilisation in different methods of its extraction, but these figures may safely be averaged as ranging between 0·5 and 4 per cent of the content of the original ore. With regard to chloride of silver it is well established that its volatility is greatly increased by the presence of other chlorides. Plattner's experiments on the Augustin method of silver extraction† show that a mixture of 10 parts of oxide of copper, 3 of chloride of lead, and 0·6 of fused and finely-divided chloride of silver, lost, on roasting in a current of air, 6·61 per cent of the original weight by volatilisation. The sublimate, on quantitative examination, gave 63·8 per cent chloride and oxide of lead (containing 54·8 of metallic lead), 32·8 per cent of cuprous chloride (containing 21 of copper), and 3·4 of argentic chloride (containing 2·6 of silver). These figures would give 5·09 as the percentage of the loss of the chloride of silver contained in the original mixture, partly due to the volatility of chloride of silver itself, but chiefly brought about, however, by the presence of other chlorides. In the oxidising roasting of sulphuretted compounds of silver, the loss is also great, through the volatilisation of the sulphate, &c., of themselves, or increased by the presence of compounds of other metals, or through the mechanical movement of fine particles of the ore by the draught through the furnaces.

In the treatment of galena for the extraction of lead, whether by the process of reaction or by other means, a large amount of the metal is lost, chiefly in the forms of sulphate or of oxide. This loss, though admittedly large, is not fully appreciated, and is, without doubt, due, not merely to the volatility of the oxide of lead (this being partially changed into sulphate), but also to the facts that sulphate of lead is volatile, and that sulphide of lead is readily and rapidly volatilised at elevated temperatures and is subsequently converted into sulphate either through the action of the oxygen of the air or through that of sulphuric acid. This latter production of sulphate is well established by the researches of Plattner,‡ and his observation of pseudomorphous crystals of plumbic sulphate after sulphide of lead, which had formed after the condensation of the latter crystals from a vaporous condition. The writer of this communication has invariably observed during repeated exhaustive analyses of the so-called Bartlett white-lead, and of oxide of zinc produced at the Keystone Zinc Works, the presence of sulphide of lead. Both of these substances are essentially mixtures of oxide of zinc and plumbic sulphate obtained by the treatment of mixed galena and blende by the well-known process for the manufacture of zinc-white directly from the ores. On treatment with hyposulphite of soda, the sulphate of lead is readily dissolved, whilst a subsequent addition of dilute acetic acid will dissolve the remaining ingredients, leaving a small amount of dark metallic particles, which, on chemical and microscopic examination, are found to be minute crystals of sulphide of lead.

Mr. G. T. Lewis, a well-known manufacturer of Newark, Del., has repeatedly completely volatilised several hundred pounds of the purest galena obtained in the Wisconsin lead region. The products of these treatments (which were chiefly conducted in the Wetherill furnace for the manufacture of zinc-white), were collected by the "bag process," and have been analysed by the author. They are mixtures of sulphate of lead (commonly about 60 per cent), with some oxide of lead and zinc, and carbonate and sulphite of lead, and invariably contain small and variable amounts of sulphide of lead.* From these experiments the high degree of volatility of this last-named compound must be admitted, unless it be claimed that it is first converted into sulphate, and that this salt is even more volatile than the sulphide. The author has made efforts to establish the degree of volatility of the sulphide of lead by strongly heating the artificially prepared salt in currents of nitrogen and hydro-sulphuric acid, but has found so many difficulties in the preparation of a perfectly dry and unaltered compound, that he cannot, as yet, regard his results as removed beyond sources of fallacy,

Plumbic sulphate is also to a slight degree volatile. Some of the perfectly dry and pure artificially prepared salt was strongly heated for one hour, in a porcelain tube through which a current of dry air freed from carbonic acid was drawn. Thus treated, 1·4082 grms. of the sulphate lost in weight 0·0019 grms., equivalent to 0·134 per cent. A second experiment with 4·2761 grms., but heated for upwards of two hours, showed a loss of 8·5 milligrammes, or a little less than 0·2 per cent. Other trials showed variable losses, but in no instance was the percentage amount greater than that obtained in the second experiment. Examined with a glass, indications of fusion of the sulphate were noticed. That this method of producing sulphate of lead in lead smoke or fumes is of much moment compared with that of the volatilisation and subsequent oxidation of the sulphide, can hardly be claimed, though it, doubtless, is one of the many causes of the loss of lead in metallurgical operations.

Another cause of loss is the mechanical one brought about by the currents of air, or of the products of combustion sweeping through the furnaces. In furnaces of that description, where the fuel is intermingled with the ore under treatment, or where the gases, vapours, &c., from the fuel in the fire-box pass over and in contact with the charge, this mechanical loss is, doubtless, increased by the presence of fuliginous particles of finely-divided carbon, which enclose, and, as it were, buoy up, the denser particles of metallic compounds. Where the metallurgist has to deal with lead ores which contain zinc compounds —by no means an unusual condition of affairs—it will be admitted that the formation of zinc vapours and their subsequent conversion into the specifically light oxide of zinc, will add greatly to the loss of lead as sulphide or as oxide by assisting mechanically in carrying these compounds from the furnace in a manner similar to that in

* From advance-sheets of the *Journal of the Franklin Intsitute*. Communicated by the Editors.

† *Berg-und Huttenmänische Zeitung e*, 1854, p. 125 *et. seq.*

‡ *Procedes Metallurgiques de Grillag e*, p. 207 *et seq.*

* The method of analysis followed in these investigations was essentially that described by the author in the *Journal of the Franklin Institute*, for March, 1869.

which the sooty particles of carbon may act. The volatility of silver as oxide or as sulphate may be fairly assumed as increased in this same manner. The experiments of Malaguti and Durocher,* made with argentiferous zinc blende, indicate that the loss of silver in the presence of zinc compounds may be very considerable, reaching as much even as 70 per cent of the original content of the ore, but ranging usually according to the richness of the ore in silver and in zinc, and according to the management of the furnaces, between 15 and 60 per cent.† A small proportion of this loss is unquestionably due to the volatility of the sulphate of silver, but, as in the case of ores not carrying zinc, and not highly siliceous, the loss is less than 10 per cent,‡ it must be admitted that zinc compounds dispose silver to volatilise.

The ores mined in the Silurian lime-stones of Sinking Valley are chiefly intimate mixtures of zinc blende and galena (the latter forming usually about 20 per cent of the mixture), and contain on the average, by the assays of the author, about 5 ounces of silver to the ton of 2000 lbs., though Ashmead finds‖ by his assays 8·5 and 9 ounces. These ores are treated, at the Keystone Zinc Works, for the manufacture of zinc-white by the ordinary process, and in the residues on the perforated grate bars of the furnace, the writer has never been able to find weighable quantities of silver, though operating repeatedly on amounts of 58½ grms. By dissolving a weighed amount of the so-called "oxide" made from this ore and collected in the "bags" in nitric acid, evaporating to dryness, adding hydrochloric acid, extracting with water, and assaying the residue in the usual manner, 0·014 per cent of silver may be found, corresponding to 4·2 ounces to the ton of "oxide." The "Bartlett white-lead," prepared in a similar manner from mixed blende and gelena, mined in Davidson county, North Carolina, yields a somewhat smaller percentage of silver (0·0087 per cent) though the original ore is more highly argentiferous than that utilised in Pennsylvania. This discrepancy may be accounted for, however, by the fact that the North Carolina ore is roasted (with the addition of salt?) at the mine before shipment to New Jersey for its conversion into the basis of a pigment.

The following analyses will exhibit the composition of lead fumes by various operations :—

	I.	II.	III.	IV.	V.	VI.
ZnO	72·083	73·426	49·50	13·80	25·70	9·23
PbO	0·274	—	27·90	10·20	48·30	13·21
SbO_3	trace	—	AsO_3 2·10	—	3·90	—
Fe_2O_3	trace	—	—	3·40	—	trace
$PbOSO_3$ ..	23·968	25·084	13·00	66·60	14·40	74·05
$ZnOSO_3$ ..	0·810	0·574	—	PbS 1·40	—	trace
ZnCl	0·839	—	—	—	—	—
Fe_2Cl_3	0·071	—	—	—	—	—
$SbCl_3$	trace	—	—	—	—	—
CdCl	0·256	—	—	—	—	—
$CdOSO_3$ ..	—	0·187	—	—	—	—
$CaOCO_2$ ..	— and loss }	0·729	CO_2 7·00	—	4·50	3·27
Clay	—	—	—	5·60	—	SO_2 0·84
Per cent Pb. in above ..	16·624	17·132	34·778	56·169	54·571	62·840
Ag.	0·0087	0·014	—	—	—	0·0019

Analyses I., II., and VI. are by the author; III., IV., and V. are from Watts's "Dictionary of Chemistry," Art. "Lead." No. I. is the so-called Bartlett White Lead (*Journal of the Franklin Institute*, March, 1869); II. is the zinc-white from the ores of Sinking Valley, Pennsylvania; III., fumes from blast furnaces at Freiberg; IV., fumes from reverberatory furnace at Alston Moor; V., from refinery at Freiberg; VI., from Wisconsin ores treated at Birmingham, Pennsylvania, in the Wetherill furnace for the manufacture of zinc-white; Nos. I. and II. were also obtained by treatment in the same furnace. The three analysed by the author all contained sulphide of lead, but the amounts were small and were not estimated.

Estimates based upon the treatment of a large amount of ores have given the following figures, making evident the loss in the treatment of lead ores by conversion into merchantable lead, though unfortunately no descriptions of the characters of the ores are furnished. A blast hearth furnace treating 267,008 pounds, yielding by assay 75·75 per cent, or 202,258 pounds, gave 178,895 pounds or 67·00 per cent, exhibiting, therefore, a loss of 23,363 pounds. The refining process gave a further loss of 13·40 per cent, whilst the reduction of the dross from the refinery added a still further loss of 3·60 per cent, giving an aggregate of more than 28½ per cent of the original content of lead.*

If considerations of the health and property of a neighbourhood are only of subordinate importance, such figures must make evident the necessity of connecting with lead establishments, suitable apparatus for the condensation and saving of this fume. The process of straining the fumes through muslin or fine canvass, which gives such successful results in the collection of zinc fume or oxide as exemplified by the well-known "bag process," has not received from metallurgists the attention its simplicity and completeness merit. From experiments made on a large scale on galena ores, both nearly pure and containing a large amount of blende, the writer is satisfied that its application to the condensation of lead and other metallic fumes would leave little to be desired. It seems strange that it has not been applied to purposes other than the mere saving of oxide of zinc, especially when the necessity of a thorough collection of metallic fume is considered. Its satisfactory use in the treatment of sulphuretted ores, it is true, would be somewhat lessened by the fact that the fabric of the bags would be rapidly destroyed by sulphuric acid, &c.; but even this difficulty might be obviated by washing the mixed gases and metallic vapours by conducting them into a brick chamber through which water in the form of rain is falling. The water from this chamber might be run off through caustic lime to remove soluble metallic salts. The ordinary blower working in the flues between the zinc furnaces and the bags would prevent any injury to the draught of the furnace.

A discussion of the various mechanical devices and combinations already in use in England and elsewhere, for preventing or reducing the loss by volatilisation at lead furnaces, is not deemed necessary in this connection. The results of Von Patera's experiments† made on a small scale, and having in view the saving of argentiferous fume through chemical reagents and reactions, may yet be found to contain the germs of important technical applications. Especially may this be true of those obtained by the use of sulphydric acid, whereby waste sulphurous acid may be converted into sulphur, and a complete saving of volatilised silver and lead compounds be effected.

* *Annales des Mines*, xvii., 1850.
† Plattner, *loc. cit.*, p. 118.
‡ Kerl's *Handbuch der Huttenkunde*, i., 2nd edition, p. 89.
‖ *American Chemist*, vol. i., No. 4, p. 134.

* These figures are condensed from the elaborate tables in Watts's "Dictionary of Chemistry."
† *Zeitschrift für Berg und Hüttenwesen*, 1854, p. 33.

CORRESPONDENCE.

PRODUCTIVE POWERS OF SOILS IN RELATION TO THE LOSS OF PLANT FOOD BY DRAINAGE.

To the Editor of the Chemical News.

SIR,—The few remarks I made on the subject of Dr. Voelcker's lecture at the Chemical Society have been, to some extent, imperfectly reported in your Journal. With regard to sewage-irrigation, I did not argue against its utility, but against the probability of the immense

return in produce from its use which some authorities lead us to expect; and with respect to the retention of nitrates by soil, I did not believe there was any evidence that nitrates were well retained by soil, but simply that some facts seemed to show the existence of a small power of retention, which had hitherto been overlooked.—I am, &c.,

R. WARINGTON.

MISCELLANEOUS.

A Manual of Organic Chemistry, by Dr. Henry E. Armstrong, F.C.S., Professor of Chemistry in the London Institution, is advertised by Messrs. Longmans and Co., as being in preparation for their series of Text-books of Science.

Alexander's Air Purifier.—This is an ingenious arrangement for disinfecting sick chambers, hospital wards, &c., with carbolic acid, an alcoholic solution of sulphurous acid, or disinfecting powder. During illness and infectious diseases, the purifier is hung in each room, passage, cupboard, and wardrobe, and a regulator is opened so as to allow the odour of the disinfectant to be distinctly perceived.

Pharmaceutical Conversazione.—The annual conversazione of the Pharmaceutical Society was held on Wednesday evening last at the South Kensington Museum. About 3000 visitors were present. In addition to the attractions of the museum, a selection of instrumental music was performed by the band of the Grenadier Guards, and the Orpheus Glee Union, under the direction of Mr. Fielding, contributed to the pleasure of the evening by singing several glees.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Annalen der Physik und Chemie, von Poggendorff, No. 2, 1871.

This number contains the following original papers and essays more strictly belonging to chemical and collateral sciences:—

Optico-Experimental Researches.—Dr. G. Quincke.—The continuation of a lengthy memoir. This part contains the following chapters:—On the change of the phase during the refraction of the waves of light; on the change of the phase during the reflection of the waves of light; reflection in glass. The first portion of this monograph, not yet concluded, was published in the above-named periodical in 1866.

Power of Electro-Magnets to Carry Weights.—Prof. A. von Waltenhofen.—The contents of this paper cannot be well understood without the reproduction of the accompanying engravings.

A Curious Fountain.—M. H. Vogelsang.—This lengthy paper contains the record of a curious occurrence which took place near Delft (Holland). It appears that, in order to obtain fresh water for domestic purposes, a so-called Norton pump-tube was being rammed down in the alluvial soil (peat-bog chiefly). When at a depth of 17·5 metres below the surface, and very nearly as much below sea level at that locality, the ram-block was suddenly lifted by a mass of gas issuing from the opening of the iron tube, immediately followed by water, which rose to a height of 14 metres, and continued to do so for some fourteen hours; after that lapse of time, the fountain became for a few weeks intermittent. The temperature of the water was 13°. The composition of the gas, in 100 parts, by bulk, was found, by Dr. A. C. Oudemans, jun., to consist of 91·2 of marsh gas and 8·2 of carbonic acid, with traces only of air, while carbonic oxide and heavy hydrocarbons were proved to be absent. The phenomena alluded to ceased when, after some weeks, the iron pump-tube was forced down to a depth of 25 metres.

Theory of Marine Currents.—Dr. von Witte.

Researches on Alcoholic Fermentation, and on the Nutrition of the Saccharomyces cerevisiæ.—Dr. A. Mayer.—This paper contains the results of a series of physiologico-chemical researches on the development, functions, growth, and composition of a peculiar kind of cryptogamic vegetable (*Saccharomyces cerevisiæ*), which the author considers to be the cause of fermentation.

Combination of Acetate of Soda with Water.—Dr. E. Zettnow.—The main result of the author's researches is that acetate of soda is capable of combining with very variable quantities of water, viz:—

$C_4Na_2H_6O_4+6H_2O=39·70$	per cent of	water.
$C_4Na_2H_6O_4+5H_2O=35·40$	"	"
$C_4Na_2H_6O_4+4H_2O=30·51$	"	"
$C_4Na_2H_6O_4+3H_2O=24·77$	"	"
$C_4Na_2H_6O_4+2H_2O=18·00$	"	"
$C_4Na_2H_6O_4+1H_2O=9·89$	"	"

Barometer without Mercury.—A. Heller.—Without the reproduction of the engravings added to this lengthy essay, it is not possible to give an account of the complex apparatus here alluded to.

Reversion of the Sodium Line.—M. A. Weinhold.

Observations on the Asteric Figures met with on Certain Crystals.—Dr. H. Baumhauer.

Critical Review of a Paper ("Sur les Crystallites") by Dr. Vogelsang.—Dr. E. Weiss.—Illustrated with engravings.

Pharmaceutische Zeitschrift für Russland, No. 1, 1871.

This number contains only the following original paper bearing upon chemistry:—

Nutritive Value of Extract of Meat.—Dr. J. von Liebig.—This paper has been written by the author specially as a reply to a short note on extract of meat, published in a German newspaper by a Russian, Dr. Beljawsky, who placed extract of meat in the category of various nostrums, to which applies the "*mundus vult decipi.*" The eminent author vindicates his character, and gives a well-deserved rebuke to the party just named. The paper does not, however, contain anything new on the subject.

Nos. 2, 3, and 4, 1871,

Do not contain any original papers relating to chemistry.

No. 5, 1871.

This number contains the following original paper:—

Quantitative Estimation of Arsenious Acid by means of Marsh's Apparatus.—Dr. J. Trapp.—This paper strictly treats on a method by means of which it is possible to exhibit in courts of law the presence of arsenic in cases where the detection of this substance may be required for forensic purposes; while the author sets also forth how, approximatively, some idea may be given of the quantity of arsenic which was present in either stomach, liver, spleen, or other organ. The contents of the paper bear, however, entirely upon the criminal mode of procedure in Russia.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, March, 1871.

This number contains the following original papers more strictly relating to chemistry:—

Simple Method for the Preparation of Mercurous Chloride (Calomel).—Dr. Uloth.—This paper records a series of experiments made by the author for the purpose of testing the fitness of the preparation of calomel by the wet way, by causing oxalic acid to act upon mercuric chloride (corrosive sublimate), whereby, provided the operation is assisted by good sunlight, there is formed carbonic and hydrochloric acids and mercurous chloride, according to the formula $2HgCl+C_2O_4,HO=2CO_2+Hg_2Cl+HCl$. The conclusion come to by the author is that this method—although attended with some loss, because, practically, there is not obtained as much calomel as there should be according to theory—is yet available in practice, since, with due care, the resulting calomel is very pure, while a real loss of mercury is not actually sustained, some of it being recovered as oxide.

Journal für Gasbeleuchtung und Wasserversorgung, Nos. 6 and 7, 1871.

These numbers do not contain any other papers than those strictly bearing upon gas and waterworks engineering.

Zeitschrift für Chemie von Beilstein, No. 4, 1871.

Some of the Derivatives of Camphoric Acid.—Dr. F. Wreden.—This paper treats on the following substances:—Anhydride of bromcamphoric acid, $C_{10}H_{16}O_4+Br_2=C_{10}H_{15}BrO_3+HBr+H_2O$. The body thus obtained is more difficultly soluble in ether than camphoric acid anhydride; it crystallises from its alcoholic solution in needle-shaped crystals, is readily soluble in chloroform, and becomes blackened when heated to 100°. Oxycamphoric acid anhydride, $C_{10}H_{14}O_4$, obtained from the above-mentioned body by boiling with water, fuses at 201°, is soluble in ether, alcohol, and water, and forms salts with bases, most of which are crystalline; the cadmium salt, $Cd(C_{10}H_{15}O_4)_2.3H_2O$, yields prismatically-shaped crystals, and loses at 100° all the water it contains. The ether of this acid, $C_{10}H_{15}(C_2H_5)O_4$, obtained by saturating the solution of the anhydride in absolute alcohol with HCl, is

crystalline solid body, fusing at 63°, and soluble in alcohol, ether, chloroform, and sulphide of carbon. A hydrocarbon, C_8H_{14}, obtained from the anhydrous acid by distillation with lime, was found to have a vapour density = 3·75, a sp. gr. = 0·814 at 0°, and to exhibit a smell of oil of turpentine and camphor, mixed.

Nitrited Ortho-Toluidine.—Dr. F. Beilstein and A. Kuhlberg.—Nitrited ortho-acetoluid, $C_7H_6(NO_2).NH(C_2H_3O)$, is obtained by treating ortho-acetoluid with very strong nitric acid kept in a freezing mixture. This body crystallises in rhombic-shaped prisms, fuses at between 101° and 102°, is readily soluble in boiling alcohol, almost insoluble in boiling water, and yields, by being decomposed with the requisite quantity of alcoholic potassa solution, nitro-ortho-toluidine, $C_7H_6(NO_2).NH_2$, soluble in water, fusing at 134°, readily soluble in acids, and re-precipitated from these solutions by ammonia.

The Cerite Metals.—Dr. C. Erk.—This very lengthy monograph, illustrated by some woodcuts relating to the spectrum analysis phenomena of the metals alluded to, is divided into the following chapters:—Separation of cerium from lanthanum and didymium; separation of lanthanum from didymium; absorption-spectrum of didymium solutions; separation of yttria from the oxides of lanthanum and didymium; composition of the oxides of cerium; cero-ceric hydroxide; on the quantity of water contained in oxalate of cerium; composition of cero-ceric sulphate; basic salts; basic cero-ceric sulphate; basic cero-ceric nitrate; basic cero-ceric acetate; electrolytic experiments made with fused cero-chloride; concentrated cero-sulphate solution; neutral cero-nitrate solntion; basic cero-ceric acetate solution.

Preliminary Notice on a Crystallised Xylol, Dimethyl-Benzol.—P. Jannasch.—The author prepared perfectly pure dimethyl-benzol from perfectly pure crystalline bromotoluol, iodmethyl, and sodium, obtaining a body crystallised at 135°, which, on being cooled, and afterwards purified, yielded a solid crystalline substance, boiling at 136°, fusing at 15°, and found to consist, on being analysed, of C_8H_{10}. The author is engaged with further researches on this compound and its derivatives.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 2, 1871.

The only paper relating to physico-chemical sciences in this number is the following:—

Note on the Quality of our Ancient Limestones, as regards their Fitness for Building Purposes.—M. J. J. Omalius d'Halloy. The main gist of this paper is, that it is not so much the texture of the limestones which has to be taken into consideration, since the structure and texture of these stones may vary immensely, and yet they may all be suited for building purposes, provided the layers or beds have not been, as very frequently is the case, dislocated by geological upheavings, whereby many of these kinds of stone become foliated, and do not then withstand wind and weather for any length of time without crumbling to pieces.

No. 3, 1871.

Contains—

Note on the Aurora Borealis observed at Brussels on the 12th of February last.—M. A. Quetelet.

Observations on the Action of Iodate of Potassium upon Animals.—Dr. Melsens.—The record of some experiments upon dogs, to which this salt was given along with their food. The author concludes, from his experiments, that iodate of potassium is a violent poison; but this paper is only a preliminary notice, it being the author's intention to publish an exhaustive account of his experiments, and of the effects of this salt on the blood and internal organs of the animals experimented with.

NOTES AND QUERIES.

Nitrous Oxide.—(Reply to "Inquirer.")—You cannot convert nitrous oxide into nitric oxide. The latter may be converted into the former by placing it in contact with moist iron filings, zinc filings, or soluble sulphides, but the nitrous oxide so obtained is frequently contaminated with ammonia.—A. A.

Notched Teeth.—(Reply to "Reader.")—Your query is one strictly belonging to the domain of physiology, and we advise you to read the excellent article on "Teeth" in the "Cyclopœdia of Anatomy and Physiology," edited by Dr. R. Todd, vol. iv., part II., pp. 864—935 inclusive. From this it appears that there is no connection whatever between notched teeth and syphilis, the notches being due to the peculiar lamellated structure of the teeth, which by constant mastication become smooth.—X. Y. Z.

Cellulose.—(Reply to "Papyrus.")—Your best plan is to exhaust the substances in question, first with boiling water, next with boiling alcohol, then with boiling ether; then treat the residue, first with weak aqueous caustic potassa solution (1 of solid potassa in 100 of water), and, after thorough digestion and repeated washing with boiling distilled water, treat the residue with dilute sulphuric acid (1 to 7 or 8); wash again thoroughly with boiling water, dry, and treat once more with alcohol. What remains after this treatment you may consider to be cellulose, which, however, to become quite white, requires bleaching with chlorine.

Electrical Properties of Aluminium and Magnesium.—A correspondent asks about the electrical properties of aluminium. As a positive, I find it about equal to iron; and as a negative, inferior, if the iron be skilfully used. For if iron be skilfully used it is nearly equal to copper; used as a negative it should always be in such a way as to form a *black oxide* on the surface. I have lately been trying experiments with magnesium as a positive; the great evil of it is the rapid local action which takes place, which, however, by a peculiar arrangement, I have succeeded in entirely overcoming. The following results as to its properties may be of interest to your readers:—On the galvanometer I used, which presented considerable resistance, an ordinary Daniell's battery stood at 38°. With magnesium for the positive, and copper and sulphate of copper for the negative, the current rose to 55°. With magnesium as positive, and zinc for negative, I got a current of 35°; with iron for negative, 45°; the first being nearly equal to Daniell's battery, and the latter superior. With a different electrolyte, I got between zinc and copper, 46°; and magnesium and copper, 60°. With another specimen of magnesium, procured fresh this morning from Solomen's, the current rose to 67°. I then took another galvanometer showing smaller numbers, with the following results:—

Zinc and copper, in an arrangement of my own	15°
Magnesium and copper	26°
One of Grove's cells	22°
One of Bunsen's cells	26°
Magnesium, with carbon and nitric acid for negative	30°
With platinum and nitric acid	29°
Magnesium with bichromate of potass and carbon for negative	30°

Thus, magnesium with platinum and carbon is to zinc as about the tangents of 29° and 30°, respectively, to tangents of 22° and 26°; but, with iron and copper for negatives, it is to zinc nearly as 7 to 4. I think 22° for Grove's cell was rather too low, as the porous cell was new and not thoroughly soaked with the acids, and it was some time before I could get any current at all through it. Thus, magnesium and copper was equal to a Bunsen's and superior to a Grove's cell. The magnesium, with carbon and nitric acid or bichromate for a negative, is, I think, the most powerful *practical* arrangement on record, and is very constant for a long time. Sodium or potassium are, no doubt, stronger, but are difficult in the use. Probably lithium would be very powerful. If any of your readers will furnish me with a piece sufficient to try with, I will test it in my arrangement.—H. HIGHTON, Putney.

MEETINGS FOR THE WEEK.

MONDAY, 22nd.—Royal Geographical, 1. Anniversary.
TUESDAY, 23rd.—Royal Institution, 3. Rev. Prof. Haughton, "On the Principle of Least Action in Nature."
—— Civil Engineers, 8.
—— Ethnological, 4. Anniversary.
WEDNESDAY, 24th.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 25th.—Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
—— Royal, 8½.
FRIDAY, 26th.—Royal Institution, 9. Prof. Rankine, "On Sea Waves."
SATURDAY, 27th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."

TO CORRESPONDENTS.

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ERRATUM.—In Mr. H. A. Smith's paper in our last issue, p. 221, the last three lines in Table III. should read thus:—

100 tons of hard Norwegian pyrites make 140·875 tons of H_2SO_4, containing	1·051
140·875 tons of sulphuric acid make 104·9 tons of HCl, containing	0·691
140·875 tons of sulphuric acid make 204·12 tons of Na_2SO_4, containing	0·029

A. R. H.—A new edition of Mr. Sutton's "Volumetric Analysis" will shortly appear. The Editor is not engaged on a translation of Dr Mohr's work.

Merrick and Gray.—Received.

Dr. B. H. Moore.—Your letter and enclosure came duly to hand.

C. N.—"Food and its Adulterations," by Dr. Hassall, will meet your requirements; the price, we believe, is 10s. 6d.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 600.

ON THE

NITROGEN SUPPLIED TO THE SOIL IN MANURE, AND NOT RECOVERED IN THE INCREASE OF CROP.

By J. B. LAWES, F.R.S., F.C.S., and Dr. J. H. GILBERT, F.R.S., F.C.S.

REFERRING to that part of Dr. Voelcker's lecture "On the Productive Powers of Soils in relation to the Loss of Plant-Food by Drainage" in which he gave the results of his elaborate investigation into the composition of drainage-waters from differently manured experimental plots at Rothamsted, it has occurred to us that a *resumé* of some points of our own part of the enquiry might be of interest to the readers of the CHEMICAL NEWS at the present time. It is proposed, therefore, to give a brief account, chiefly in the form of quotations from, or reference to, former papers, of those of our own results and conclusions which relate to the question of the amounts of the nitrogen supplied in manure found to be recovered and not recovered in the increase of crop obtained.

In the early years of our experiments—indeed more than twenty years ago—we directed attention to the fact that when, especially in the case of graminaceous crops, nitrogen was supplied to the soil in the form of ammonia salts, or other concentrated manures, a large proportion remained unrecovered in the increase of produce obtained. It would, of course, not be expected that the whole of the nitrogen, or, indeed, of any other constituent of manure, would be gathered up by the crop which immediately succeeded its application. But it was found, on calculation, that when a given amount of nitrogen was supplied year after year, and the same description of crop was grown for a series of years in succession, generally less than half that which had been supplied was recovered in the increase of crop; whilst, if the application were discontinued, but a very small proportion of the missing amount of nitrogen would be recovered each year in the succeeding crops.

At first we were disposed to consider that this loss of nitrogen might, in part at least, be explained by reference to the vital actions of the plant itself; it having been supposed by several experimenters that plants evolved nitrogen from their leaves during growth. Thus De Saussure,* Daubeny,† and Draper‡ concluded, from experiments with plants, that such an evolution did take place. Mülder, again, from purely chemical considerations, supposed that there was a constant evolution of nitrogen during the growth of plants, and that the source of it was the compounds containing it already existing in the plants. For a fuller account of our treatment of this subject at the time we must refer to our early papers, and especially to one published in the *Journal of the Horticultural Society of London*, vol. v., part 1, 1850.‖

After showing, in a paper in the *Philosophical Transactions*, part ii., 1861,§ the relation of the increased yield of nitrogen to the amount supplied in manure in some particular cases, we submitted the following questions:—

"Is the unrecovered amount of supplied nitrogen, or at any rate a considerable proportion of it, drained away and lost?

"Are the nitrogenous compounds transformed within the soil, and their nitrogen, in some form, evaporated?

"Does the missing amount for the most part remain in some fixed combination in the soil, only to be yielded up, if ever, in the course of a long series of years?

"Is ammonia itself, or nitrogen in the free state, or in some other form of combination than ammonia, given off from the surface of the growing plant? Or, lastly—

"When nitrogen is supplied within the soil for the increased growth of the graminaceous crop, is there simply an unfavourable distribution of it, considered in relation to the distribution of the underground feeders of the crop?—the leguminous crop, which alternates with it, gathering from a more extended range of soil, and leaving a residue of assimilable nitrogen within the range of collection of a next succeeding cereal one?"

Briefly enumerated, the three main sources of loss of nitrogen here suggested are, then—*drainage, accumulation within the soil in a state of combination or of distribution unfavourable for being taken up by immediately succeeding crops*, or *evolution in some form from the surface of the growing plant.*

From some of the results reported upon in the same paper, and also from other considerations, we were led to conclude, in opposition to the view we had previously entertained, that the last-named of these, that is, *evolution from the plant*, did not take place.

With regard to *drainage*, the previous results of Professor Way,* and especially the subsequent ones of the experiments conducted at Rugby under our superintendence, for the Royal Sewage Commission,† led us to attribute great importance to that part of the subject. In the course of that enquiry, we arranged for the collection of sixty-two samples of drainage-water, the partial analysis of which was conducted by Professor Way; and, comparing the results with those on the corresponding samples of sewage, it was concluded that but a small proportion of the nitrogen of the sewage which was not obtained in the increase of produce was recovered in the drainage-water in the form of ammonia. We therefore arranged for the collection of some special samples for complete analysis, and especially for the determination of the nitric acid, if any, in both sewage and drainage-water. The results showed considerably more nitrogen in the drainage in the form of nitric acid than in that of ammonia. Indeed, it was obvious that a large proportion of that important manurial constituent of the sewage was drained away and lost. Satisfied for the time with this indication, it was not contemplated to follow up that part of our own general inquiry until the question of the accumulation of nitrogen within the soil itself had first been investigated.

When, among other field experiments made at Rothamsted, wheat had been grown, year after year, on the same land for more than twenty years, on some portions without any manure, and on others with farm-yard manure, or with various descriptions of manure, and the results obtained in the field during that period had been published, the question of the varying composition of the crop according to season and manure was resumed, and that of the accumulation of the nitrogen of manure in the soil was taken up; and the results of the latter investigation were given at the meeting of the British Association for the Advancement of Science, in 1866. After considering the difficulties of sampling, preparing for analysis, and analysing soils in such a manner as to yield results applicable to the purposes of the enquiry, and describing the

* "Recherches Chimiques sur la Végétation," 1804.

† Memoir "On the Action of Light upon Plants, and of Plants upon the Atmosphere" (*Phil. Trans.*, part i., 1836).

‡ "Chemistry of Plants," 1844, pp. 184-5 and context.

‖ "Experimental Investigation into the Amount of Water given off by Plants during their Growth, especially in relation to the Fixation and Source of their Various Constituents."

§ "On the Sources of the Nitrogen of Vegetation, with special reference to the question whether Plants Assimilate Free or Uncombined Nitrogen," by Lawes, Gilbert, and Pugh.

* "On the Composition of the Waters of Land Drainage and of Rain" (*Journ. Roy. Ag. Soc. England*, vol. xvii., part i.)

† "On the Sewage of Towns" (Third Report and Appendices 1, 2, and 3, of the Royal Commission, 1865). "On the Composition, Value, and Utilisation of Town Sewage (*Journ. Chem. Soc.*, new series, vol. iv.; entire series, vol. xix., 1866.)

methods adopted, the results themselves, arranged in tables, were discussed. The percentage and calculated acreage amounts of nitrogen, existing in such condition as to be determinable by burning with soda-lime, were given, for the soil of the first, of the second, and of the third 9 inches in depth, of eleven differently manured plots, showing, therefore, both percentage and actual amounts to the depth of 27 inches in all.

In the short abstract only that was published, the results and conclusions were summarised as follows:*—

"The accumulation of nitrogen from the residue of manuring was found to be, in some cases, very considerable; but, even with equal amounts supplied, it varied, both in total amount and in distribution, according to circumstances, the depth to which the unused supply had penetrated being apparently influenced by the character and amount of the asssociated manurial constituents. The general result was, that although a considerable amount of the nitrogen supplied in manure, which had not been recovered as increase of crop was shown to remain in the soil, still a larger amount was as yet unaccounted for. Initiative results indicated that some existed as nitric acid in the soil, but it was believed that the amount so existing would prove to be but small. In fact, it was concluded that a considerably larger proportion would remain entirely unacccounted for within the soil to the depth under examination than was there traceable, and the probability was, that at any rate some of this had passed off into the drains, and some into the lower strata of the soil. Finally, it was shown, by reference to field results, that there was not more than 1 or 2 bushels of increase in the wheat crop per acre per annum, due to the large accumulated residue of nitrogen in the soil, notwithstanding its amount was many times greater than that which would yield an increase of 20 bushels or more, if applied afresh to soil otherwise in the same condition. On the other hand, it was shown that the effect of an accumulated residue of certain mineral constituents was not only very considerable in degree, but very lasting."

Thus, then, it was established, that there was a considerable accumulation within the soil, of nitrogen supplied in manure and not recovered in the increase of crop, but that there remained a considerable quantity not so accounted for; and it was concluded that some of this had passed off into the drains, and some into the lower strata of the soil. Being fully occupied at the time with other subjects, and finding that Dr. Voelcker was desirous to investigate the question of land drainage, we gladly provided him with samples of the drainage water from the differently manured plots in the experimental wheat-field, and also with full particulars of their history for the purposes of inquiry. The results of the seventy complete analyses of drainage water of accurately known history, which he has published in his lecture will, we doubt not, prove a most valuable contribution to our knowledge, and an important aid to the future study of the subject, not only in its agricultural bearings, but also in relation to the question of the influence of the sources of potable and other waters upon their composition and quality.

Referring to Dr. Voelcker's own paper for any account of his results and conclusions, we will only further observe that, it being established beyond all question that land-drainage may carry off as nitrites and nitrates large quantities of the nitrogen supplied as manure, it becomes a matter of great practical importance to consider the power of different descriptions of soil to retain the nitrogen supplied to them, to estimate approximately the probable average proportion of the rainfall which may pass from them as drainage water, and to determine, accordingly, the best modes, and the best periods of the year, for the application of nitrogenous manures. In a recent paper† we have directed attention to such evidence as is at command relating to the proportion of the drainage to rainfall in some special cases, and this subject, as well as that of the best modes, and the best periods of the year, for the application of nitrogenous manures, is now receiving attention at Rothamsted.

Rothamsted, May 18, 1871.

* *British Association Report* for 1866. See also CHEMICAL NEWS, vol. xiv., p. 122; and *Agricultural Gazette*, September 8, 1866.

† Effects of the Drought of 1870 on some of the Experimental Crops at Rothamsted. (*Journ. Roy. Ag. Soc. Eng.*, vol, vii., S.S. Part I., 1871).

NOTE ON THE SPECIFIC GRAVITY OF AQUEOUS HYDROBROMIC ACID.*

By Dr. C. R. A. WRIGHT.

THE writer having recently had occasion to prepare some little quantity of pure aqueous hydrobromic acid, advantage was taken of the circumstance to examine the relation subsisting between the specific gravity and percentage of HBr in specimens of acid of different strengths.

The acid was obtained by the action of sulphuretted hydrogen on excess of bromine in presence of water, and subsequent repeated rectification over pulverised potassium bromide; it was free from sulphuric acid and other sulphur compounds, and contained no free bromine. The percentage of HBr was determined by a standard alkaline solution, and the specific gravity by weighing a known volume of the liquid. The results, which do not pretend to very rigorous accuracy, are as follows:—

Percentage of HBr.	Sp. gr. at 15° C.
10·4	1·080
23·5	1·190
30·0	1·248
40·8	1·385
48·5	1·475
49·8	1·515

By graphical representation, it was found that these numbers agree tolerably together, yielding a *mean curve* from which the following table is constructed.

Percentage of HBr.	Sp. gr. at 15° C.	Difference for 5 per cent.	Difference in 1 per cent.
nil.	1·000	—	—
5	1·038	0·038	0·0076
10	1·077	0·039	0·0078
15	1·117	0·040	0·0080
20	1·159	0·042	0·0084
25	1·204	0·045	0·0090
30	1·252	0·048	0·0096
35	1·305	0·053	0·0106
40	1·365	0·060	0·0120
45	1·435	0·070	0·0140
50	1·515	0·080	0·0160

From these numbers it appears that the increase in specific gravity is not proportional to the increase in percentage of HBr, showing, in this respect a difference between hydrobromic and hydrochloric acid.

The numbers in the foregoing table agree tolerably with rough determinations given by other experimenters; thus C. G. Williams (*Jahresberichte*, 1858, p. 438) finds acid of 37 per cent HBr has sp. gr. 1·32: that deduced from the Table for this strength is $1·305 + 2 \times 0·0120 = 1·329$.

In Miller's "Chemistry," 4th edition, vol. ii., p. 146, acid of *about* 47 per cent HBr is said to have sp. gr. 1·486 (authority not stated); the sp. gr. deduced from the Table is $1·435 + 2 \times 0·0160 = 1·467$, the sp. gr. 1·486 representing 48·2 per cent HBr.

In many text-books, however (Watts's "Dictionary," vol. i., p. 673; Gmelin's "Handbook," vol. ii., p. 281;

* Read before the Newcastle-upon-Tyne Chemical Society, January 26th, 1871.

Brande's "Chemistry," &c.), the specific gravity of the densest aqueous hydrobromic acid is given, on the authority of Löwig, as 1·29; if this number be correct, the solubility curve must be a very abnormal one, the curvature up to 50 per cent HBr being *convex* towards the horizontal base line, while at some higher percentage a point of contrary flexure will be found, after which the curve becomes *concave* towards the horizontal line, and approaches this line instead of receding from it. It would appear much more probable that the acid employed by Löwig contained a large quantity of hydrochloric acid, a saturated aqueous solution of this acid having only a sp. gr. of about 1·2. As yet, stronger acid than 50 per cent has not been examined, but it is proposed to determine the form of the solubility curve for higher percentages of HBr.

The foregoing experiments were made in the laboratory of Messrs. Bell, Brothers, Washington.

ON BRITTLE SILVER.

By A. H. CHURCH, M.A.

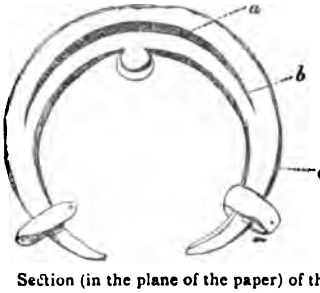
THE examination in my laboratory of some ancient silver ornaments has led to a curious result, which may prove of interest to some of the readers of the CHEMICAL NEWS.

The silver objects referred to were obtained lately by General de Cesnola in the island of Cyprus. He opened several hundreds of tombs, specially at Dali, the site of the ancient city of Idalium, and obtained large quantities of specimens of antique glass and metal-work. I believe the silver specimens with which the present note is concerned cannot have an antiquity of less than 1500 years, but the date of their manufacture may prove to have been even more remote. It is necessary to say a few words concerning the form of the particular object of silver which I have specially examined. It is, or rather was, a fibula, or, at least, was shaped like a fibula. It resembled a crescent in that the ends of the bow were small and pointed and its middle much stouter; sections throughout were nearly cylindrical, and in the widest part about ¼-inch in diameter. The specimen was nearly covered with a dark sub-metallic crust, and underneath this a soft powdery grey substance was observable. Both these layers, which together presented an average thickness of 1-30th of an inch, could be readily removed by the finger-nail. Below, the substance appeared white, metallic, and uniform, but yet was remarkable for its extreme brittleness, the object being easily snapped in numerous pieces by a very slight pressure. If the brittleness had pertained to the outer crust or layer, obviously altered as it was, it would not have been surprising. But to find that an apparently continuous metallic substance of great lustre, and, certainly once, at the time of its manufacture, in a perfectly ductile condition (for portions of it had been twisted into fillets), to find this metallic substance as brittle as a stick of chalk was certainly difficult to explain. And a further difficulty was offered by the observation that in the thicker part of the crescent, and only there, a kind of core existed similar in colour to the main mass of the object, but possessing great tenacity and ductility. This core could not be broken short off, but might be wrenched out of the surrounding brittle mass, though with some difficulty. It tapered off towards the narrower ends of the crescent, and terminated where those parts did not exceed ¼th of an inch in thickness. A physical and chemical examination of the materials enables me to offer a reasonable explanation of the observed appearances.

The outer crust consisted of the corroded and chemically altered silver-alloy. It was made up of finely-divided metallic silver, with traces of the sulphide and chloride of that metal, and it gave also a faint trace of iodide; copper, apparently in the form of a basic carbonate, was likewise present, with a trace of gold. The main part of the specimen consisted of the second and extremely brittle layer referred to before. It gave on analysis the following composition:—

	Per cent.
Silver	94·69
Gold	0·41
Copper	3·43
Lead	0·28
Antimony with trace of arsenic and bismuth	1·21
	100·02

The central ductile and malleable core had *precisely* the same composition as this brittle layer. To what, then, are the physical differences between them to be attributed? Not to chemical differences or chemical changes, but to a *molecular change* which, in the course of ages, has occurred throughout all the thinner parts of the piece of silver, but had left unchanged in the thickest part a central fusiform core. A crypto-crystalline structure had been produced in the previously homogeneous alloy, which caused the peculiarly easy fracture of the metal. A smart blow with a hammer was capable of shattering it to powder, while by rolling or gentle hammering, the brittle mass could be restored readily to its pristine condition. The density of



Section (in the plane of the paper) of the silver object referred to.

the brittle silver was 9·06, but, by rolling, it became 10·20. There was not, therefore, a chemical change, but a physical one. However produced, whether by minute and long-continued alterations of temperature, or by other agencies, this molecular change of silver may possibly throw some light upon the similar change observed in the case of iron.

ON THE REVIVED THEORY OF PHLOGISTON.*

By WILLIAM ODLING, M.B., F.R.S.
Fullerian Professor of Chemistry, Royal Institution.

Observationem, quam produco, bono jure mihi vindico. . . Materia hæc ignescens, in omnibus tribus regnis, una eademque existit. Unde, ut e vegetabili in animale, abundantissime transmigrat, ita ex utrolibet horum, in mineralia et ipsa metalla, promptissime omnium transfertur.—*Stahlii*, Experimenta, Observationes, Animadversiones, CCC, Numero.

IN 1781—83, Cavendish showed that when inflammable air or hydrogen, and dephlogisticated air or oxygen, are exploded together in certain proportions, "almost the whole of the inflammable and dephlogisticated air is converted into pure water," or, as he elsewhere expresses it, "is turned into water."

On June 24, 1783, the experiment of Cavendish was repeated on a larger scale and in a somewhat different form by Lavoisier, who not only confirmed the synthesis of the English chemist, but drew from it the conclusion—at first strongly contested, then rapidly acknowledged, and since never called into question—"that water consists of in-

* A Lecture delivered at the Royal Institution of Great Britain, April 28th, 1871.

flammable air united to dephlogistigated air," or that it is a compound of hydrogen and oxygen.

This conclusion, so opposite to his own preconception on the matter, Lavoisier subsequently confirmed by an analysis of water. He found that iron, heated to redness and exposed to the action of water-vapour, became changed by an abstraction of oxygen from the water, into the self-same oxide of iron procurable by burning the metal in oxygen gas,—the other constituent of the water, namely, its hydrogen, being freely liberated.

With the demonstration by Lavoisier of the composition of water began the triumph of that antiphlogistic theory, which he had conceived, in a necessarily imperfect form, so far back as 1772, or before the discovery of oxygen, and had brought to completion by the aid of every successive step in pneumatic chemistry, achieved by himself or by others.

In 1785, the relationship to one another of hydrogen and water being then conclusively established, Berthollet declared himself a convert to the new theory of combustion put forward by his countryman. Fourcroy next gave in his adhesion; and soon afterwards De Morveau, invited to Paris expressly to be reasoned with by Lavoisier, succumbed to the reasons set before him. The four chemists then associated themselves together, and in spite of a strong though short-lived opposition both in England and Germany, succeeded in obtaining for *La Chimie Française* an all but universal recognition.

The principal articles of the new or antiphlogistic theory of combustion propounded by Lavoisier are as follows:—That combustible bodies in burning yield products of various kinds—solid in the case of phosphorus and the metals, liquid in the case of hydrogen, gaseous in the case of carbon and sulphur. That in every case the weight of the products formed by the burning is greater than the weight of the combustible burnt. That the increase of weight is due to an addition of matter furnished to the combustible by the air in which its burning takes place. That bodies of which the weights are made up of the weights of two or more distinct kinds of matter are of necessity compound; whereas bodies of which the weights cannot be shown to be made up of the weights of two or more distinct kind of matter are in effect simple or elementary. That inasmuch as the weights of the products furnished by the burning of different combustibles are made up of the weights of the combustible burnt and of the oxygen consumed in the burning, these products are compound bodies—oxides, in fact, of the substances burnt. That inasmuch as given weights of many combustibles, as of hydrogen, sulphur, phosphorus, carbon, and the metals, are not apparently made up of the weights of two or more distinct kinds of matter, these particular combustibles are in effect elementary; as for the same reason is the oxygen with which in the act of burning they enter into combination. And, lastly, that combustion or burning consists in nothing else than in the union of combustible matter, simple or compound, with the empyreal matter, oxygen—the act of union being somehow attended by an evolution of light and heat. And except that it would be necessary nowadays to explain how, in certain cases of combustion, the combustible enters into union, not with oxygen, but with some analogue of oxygen, the above precise statement might equally well have been made by Lavoisier in 1785, or be made by one of ourselves at the present day.

Lavoisier's theory of combustion being known as the antiphlogistic theory, the question arises, What was the phlogistic theory to which it was opposed, and which it succeeded so completely in displacing? This phlogistic theory was founded and elaborated at the close of the seventeenth century by two German physicians, Beccher and Stahl. Having exercised a scarcely disputed authority over men's minds until the notorious defection in 1785, it preserved for some years longer a resolute though tortuous existence, and was to the last defended and approved by our own Priestley and Cavendish—who died, the former in 1804, and the latter in 1810.

The importance attached to the refutation of this theory may be judged of from the circumstance, that after the early experiments of Lavoisier on the composition and decomposition of water had been successfully repeated by a committee of the French Academy in 1790, a congratulatory meeting was held in Paris, at which Madame Lavoisier, attired as a priestess, burned on an altar Stahl's celebrated *Fundamenta Chemiæ Dogmaticæ et Experimentalis*, solemn music playing a requiem the while. And the sort of estimation in which the Stahlian doctrines have since been held by chemists is fairly illustrated by a criticism of Sir J. Herschel, who, speaking of the phlogistic theory of chemistry, says that it "impeded the progress of the science, as far as a science of experiment can be impeded by a false theory, ... by involving the subject in a mist of visionary and hypothetical causes in place of the true acting principles." Possibly, however, this much-abused theory may yet prove to contain an element of permanent vitality and truth; anyhow the study of this earliest and most enduring of chemical theories can never be wholly devoid of interest to chemists.

To appreciate the merit of the phlogistic theory it is necessary to bear in mind the period of its announcement. Its originator, Beccher, was born in 1625, and died a middle-aged but worn-out man in 1682, a few years before the publication of the "Principia." His more fortunate disciple, Stahl, who was born in 1660, and died in 1734, in his seventy-fifth year, though afforded a possibility of knowing, seems equally with Beccher to have remained throughout his long career indifferent to the Newtonian principle that the weight of a body is proportionate to its quantity of matter—that loss of weight implies of necessity abstraction of matter, and increase of weight addition of matter. Whether or not the founders of the phlogistic theory conceived that change of matter in the way of kind, might equally with its change in point of quantity, be associated with an alteration in weight—and it must not be forgotten what pains Newton thought it necessary to take in order to show the contrary—certain it is they attached very little importance to the changes of weight manifested by bodies undergoing the metamorphosis of combustion. It might be that when combustible charcoal was burned the weight of incombustible residue was less than the original weight of charcoal—it might be that when combustible lead was burned the weight of incombustible residue was greater than the original weight of metal—this was far too trifling an unlikeness to stand in the way of the paramount likeness presented by the two bodies. For the lead and charcoal had the common property of manifesting the wonderful energy of fire; they could alike suffer a loss of light and heat—that is, of phlogiston—by the deprivation of which they were alike changed into greater or less weights of inert incombustible residue.

And not only were these primitive students of the philosophy of combustion unconscious of the fact and meaning of the relationship in weight subsisting between the consuming and the consumed body, but they were altogether ignorant of the part played by the air in the phenomena which they so boldly and successfully attempted to explain. Torricelli's invention of the barometer and Guericke's invention of the air-pump were both, indeed, made during Beccher's early boyhood; but years had to elapse before the consequent idea of the materiality of air could be domiciled, as it were, in human understandings. And not until more than a century after Torricelli's discovery of the weight of air,—not, indeed, until the time of the great pneumatic chemists, Black, and Cavendish, and Priestley, and Scheele, was it ever imagined that the aërial state, like the solid or liquid state, was a state common to many distinct kinds of matter; and that the weight or substance of a rigid solid might be largely contributed to by the weight or substance of some constituent having its independent existence in the aërial or gaseous form. The notion that 100 lbs. of smithy-scales might consist of 73 lbs. of iron, and 27 lbs. of a particular kind of air, and that

100 lbs. of marble might consist of 56 lbs. of lime, and 44 lbs. of another kind of air, was a notion utterly foreign to the older philosophy. Air, it was allowed, might be rendered mephitic by one kind of contamination, and sulphurous by another, and inflammable by a third; it might even be absorbed in, and so add to the weight of, a porous solid, as water is absorbable by sand; but still air was ever indisputably air, essentially alike and unalterable in its mechanical and chemical oneness. This familiar conception had to be overcome, and the utterly strange notion of the largely aërial constitution of solid matter to be established in its stead, by the early pneumatic chemists, Black, and Cavendish, and Bergmann, before the deficiencies rather than positive errors of the phlogistic theory could be perceived.

But long ere the foundation of modern chemistry had thus been laid, in 1756, by Black's discovery of fixed air or carbonic acid as a constituent of mild alkalies and limestone, those old German doctors, Beccher and Stahl, though ignorant of the nature of air and neglectful of the import of gravity, had yet found something to say about the chemistry of combustion worthy of being defended a century afterwards by men like Priestley and Cavendish, —worthy, it is believed, of being recognised nearly two centuries afterwards as the expression of a fundamental doctrine in chemical and cosmical philosophy. They pointed out, for example, that the different and seemingly unlike processes of burning, smouldering, calcining, rusting, and decaying, by which combustible is changed into incombustible matter, have a community of character; that combustible bodies possess in common a power or energy capable of being elicited and used, whereas incombustible bodies are devoid of any such energy or power; and lastly, that the energy pertaining to combustible bodies is the same in all of them, and capable of being transferred from the combustible body which has it to an incombustible body which has it not, rendering the body that was energetic and combustible inert and incombustible, and the body that was inert and incombustible energetic and combustible—and further rendering some particular body combustible over and over again. That this is a fair representation of the views held by phlogistic chemists is readily recognisable by a study of chemical works written before the outbreak of the antiphlogistic revolution. After Lavoisier's challenge, the advocates of phlogiston, striving to make it account for a novel order of facts with which it had little or nothing to do, were driven to the most incongruous of positions; for while Priestley wrote of inert nitrogen as phlogisticated air, Kirwan and others regarded inflammable hydrogen as being phlogiston itself in the isolated state.

(To be continued.)

ON THE DURATION OF FLASHES OF LIGHTNING.

By O. N. ROOD.

AFTER the completion of my first set of experiments on the duration of the discharge of a Leyden jar, I became anxious to make some measurements of the duration of a flash of ordinary lightning, which may be considered as equivalent to the discharge of an immense jar with an enormous striking-distance. The results of Feddersen have shown that the duration of the discharge is increased by an addition to the size of the jar, as well as by augmentation of the striking-distance, and as both these quantities are so large with a flash of lightning, it was reasonable to expect that the duration of its discharge would be prolonged in some corresponding ratio. During the violent thunder-storm of last August, which occurred in the evening, I happened to be at a house commanding an unobstructed view of the horizon, and this circumstance taken in connection with the frequency and proximity of the electrical discharges, induced me, although entirely unprovided with apparatus, to attempt a measurement of their duration. A circular disc, five inches in diameter, was hastily cut from white cardboard, while a steel shawl-pin served as an axis, on which it was made to revolve by constantly striking its edge tangentially with the right hand, the pin being held in the left. The *maximum* velocity attainable in this way was always employed. The general indications at the time were that the rate thus obtained was considerably more uniform than might have been expected, and subsequent quantitative experiments have confirmed this idea. The first experiments were made by observing black figures traced near the circumference of the disc, which was illuminated solely by the rapidly recurring flashes, and it often happened that the figures, with their details, were seen quite as clear and sharply as though the disc had been stationary; on the other hand, sometimes the edges seemed blurred, as though the disc had moved through a few degrees during the act of discharge. The result being doubtful, the mode of experimenting was quickly changed; about fifteen narrow radial apertures were made near the circumference of the disc, and the flashes and illuminated clouds were observed through these openings, the disc being made to revolve as before. The distance of the eye from the apparatus was about 8 inches, and it was of course adjusted so as to obtain distinct vision of the disc. The result was that sometimes the openings were seen quite unchanged in appearance, but more frequently they were most distinctly elongated into well-defined streaks some degrees in length. They were observed often and without difficulty, but as farther confirmation I may add that I requested Professor Joy, who was ignorant of the actual form of the aperture, to state his opinion of their apparent shape while the disc was in rotation. The reply was that they resembled Prince Rupert's drops—a not unfair description of the phenomena in question. Repeated estimates of their size were then made with paper and pencil. Some time afterward I measured the velocity which I could communicate to this disc in the manner above described, by attaching to it a small hollow axis through which the steel pin passed, the disc being then caused to wind up a thread stretched by a small weight. The rate of rotation thus attainable was found to be about twelve revolutions per second, which is a little more than I had anticipated. The average size of the streaks was 9°, corresponding to a duration of 1-480th of a second. It hence results that the duration of the flashes of lightning on the occasion referred to was in round numbers about 1-500th of a second, some of them, however, seeming to be confined to smaller limits.

I know of only a single circumstance which might militate against the correctness of the above conclusion, and it is but fair to give it such weight as it may carry. Becquerel has succeeded with some difficulty in observing a faint phosphorescence when an electric discharge is passed through rarefied air, and it is not absolutely impossible that the effects observed by me were due to a cause of this kind.

This point can hereafter readily be decided by observing with a revolving disc, not the distant clouds, but a sheet of white paper, placed so as to receive the light from the electrical flashes.—*American Journal of Science.*

ON THE REDUCTION OF SULPHURIC ACID BY ZINC-AMALGAM.*

By Dr. I. WALZ.

ALTHOUGH, as is well known, a number of oxidising agents are capable of oxidising sulphuretted hydrogen to sulphuric acid, the reverse reaction, viz., the reduction of

* Communicated by the Author. Read before the Lyceum of Natural History, New York.

sulphuric acid to sulphuretted hydrogen, has hitherto been observed only in a few cases, and even then only to a very limited extent. Messrs. Calvert and Johnson published, in 1866, some observations upon the action of zinc upon the various hydrates of sulphuric acid, in which they remark that, at a high temperature, the mono-, bi-, and ter-hydrates of sulphuric acid, when acting upon zinc, evolve principally sulphurous acid, while the fourth, fifth, and sixth hydrates, are acted upon (in the words of the *Jahresberichte*) "with a preponderating evolution of sulphuretted hydrogen," an observation which I can confirm if it is intended to say that more H_2S is formed than SO_2, but less than H, as on repeating the experiment I found that but very little H_2S was formed. According to Messrs. Calvert and Johnson, sulphuric acid which is diluted with more than six equivalents of water evolves pure hydrogen, an observation which was disproved by Kolbe, who showed that, when even chemically pure dilute sulphuric acid acts upon chemically pure zinc, a trace of sulphuretted hydrogen is always formed. In the majority of reactions, however, in which a reduction of sulphuric acid takes place, it stops at sulphurous acid, as when mercury, copper, carbon, &c., act upon the acid. Oppenheim has shown that when concentrated sulphuric acid and phosphorus act upon each other the result is phosphorous and anhydrous sulphurous acid, according to the formula $3SO_4H_2+2P=2PO_3H_3+3SO_2$.

I have lately studied the action of zinc and sodium amalgam on concentrated sulphuric acid, and have made the—in view of the foregoing remarks—somewhat unexpected observation, that in this case a considerable amount of sulphuretted hydrogen is formed. With sodium amalgam, the action is almost instantaneous. A small quantity of sodium amalgam is covered in a test-tube with an equal amount of chemically pure sulphuric acid, sp. gr. 1·84; the smell of sulphuretted hydrogen is at once perceived, and on pouring water into the test-tube the solution appears milky, from the supension of finely-divided sulphur. But the course of the reaction can be better studied by employing zinc instead of sodium amalgam, as the action proceeds slower and more regularly in this case. (In preparing the zinc amalgam, whether the zinc be used in little sticks or in filings, I find it convenient to cover the mercury and zinc with water, rendered *alkaline* by a drop of soda, potash, or ammonia. The amalgamation takes place very rapidly, and at a lower temperature, and the operator is not exposed to the noxious vapour of mercury. I prefer alkalies to acids in amalgamating zinc.)

Zinc-amalgam is placed in a small H_2S apparatus, and covered with about an equal amount of chemically pure sulphuric acid (sp. gr., 1·84), and the gases evolved are passed into a solution of acetate of lead. The first few moments only hydrogen seems to be formed, but presently the reaction becomes intense, and sulphuretted hydrogen is given off in abundance. The liquid in the apparatus becomes white, which is caused partly by the formation of anhydrous sulphate of zinc, and partly by the deposition of sulphur. There appears to be a period at which H_2S and SO_2 are formed simultaneously, and the two, reacting upon each other, give rise to an abundant deposit of sulphur. In the latter stage of the reaction sulphurous acid alone is formed. At last, the generating flask contains only mercury and white dry sulphate of zinc, that is to say, if too much sulphuric acid is not taken. (An excess of sulphuric acid should be avoided from the beginning, as the reaction towards the end generally becomes very violent in this case, volatilising mercury and sulphur, and forcing the liquid out of the flask.) If we pour water into the generating flask, the sulphate of zinc is dissolved, and the quantity of sulphur formed becomes then apparent. The mercury, immediately after the reaction is over, generally presents a bright or but slightly tarnished surface, but, on remaining in contact with the liquid, is soon covered with a black coating of sulphide. No mercury enters into solution during the reaction.

I believe that the reduction of sulphuric acid in the beginning is not gradual and successive, but is explained by the simple formula—

$$SO_4H_2+4(H_2)=4H_2O+H_2S.$$

Laboratory, 18, Exchange Place, New York.

ON THE

MOLYBDATES AND VANADATES OF LEAD,

AND ON A

NEW MINERAL FROM LEADHILLS.*

By Professor Dr. ALBERT SCHRAUF, of Vienna.

(Concluded from p. 232).

4. *Chemical Properties of the Vanadates of Lead (Dechenite, Descloizite, and Vanadite).*

EOSITE as containing vanadic acid, stands next to the just-mentioned vanadites of lead. Dechenite was first found in 1851, by M. Krantz, near Schlettenbach; and M. Bergemann, neglecting a notable proportion of zinc† contained in this mineral, has stated for it the chemical formulæ VO_3PbO. Vanadite, first found at Kappel (Carinthia), received its specified name by the late Prof. Zippe, and is, according to M. Tschermak, $PbOVO_3$. Descloizite was stated by Mr. Damour (1854) to correspond to the formulæ $2PbO,VO_3$. I have, as early as 1861,‡ emitted the opinion that these three species, concordant in a great number of properties, may be considered as being specifically identical. M. Czudnowicz (*l. c.*), in his paper on vanadite, has proffered several arguments against the vanadium supposed to enter into the composition of these minerals so near related to each other, that they must be submitted altogether to comparative investigation. The Peruvian Descloizite is of so rare occurrence, that I could not detach any particle of the small group of crystals at my disposal for the purpose of chemical investigation, being thus obliged to confine them to two varieties of vanadite from Kappel, and to a specimen of Dechenite. On two specimens of vanadite from Kappel, vanadite appears in the form of crystals intimately connected into a crust, the single crystals not exceeding the size of ¼ to ½ m.m. On one specimen (variety A), the greater number of the larger crystals is of a dark greenish-brown colour (fluorescence-colour), and without translucidity; the smaller ones are reddish brown and translucid; the streak is brownish orange. This variety agrees, in all its external characters, with the specimen of Peruvian Descloizite now before me; the crystals of it are reddish to greenish brown, translucid, and their streak is brownish orange.‖

The crystals of the second specimen (variety B) form a thin crust over limestone; they are ¼—1 m.m. in size, rather translucid, of lighter carnation tint, and less bright than those of variety A. The crystals of variety A show a vivid metallic brightness, while the light carnation ones of variety B scarcely offer a faint vitreous brightness, very easily altered by the contact with moist air; even the moisture contained in the air breathed out is sufficient to provoke a superficial decomposition of the crystals of variety B. Their brightness is immediately tarnished, and in a few minutes very diminutive greyish-white globules cover, like Mucedineæ, the surface of the

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* Abstract of a paper read before the Royal Society, May, 1871 Translated by Count A. Fr. Marschall.

† See Czudnowicz in *Poggendorff's Annalen*, vol. cxx.

‡ See Schrauf, *Poggendorff's Annalen*, vol. cxvi. I must here remark expressely, in order to avoid misunderstandings, that in the course of this paper I have purposely quoted the formulæ of precedent authors with the (older) symbols used by *them* to express vanadic acid. I do not intend to discuss the results of former analyses, because Professor Roscoe, in the course of his ingenious researches conerning vanadium, has expressly (See *Proceedings of the Royal Society*, vol. xvi., p. 226) said, "It is the author's intention to investigate the composition of the vanadates at a future time."

‖ See Schrauf "On the Identity of Vanadite and Descloizite," in *Poggendorff's Annalen*, vol. cxvi. (1861).

crystal. Some time after these globules assume a slight yellowish colour, but spread no further over the specimen as soon as it is kept in dry air. The supposition of this alteration to be caused by the presence of arsenic is contradicted by the results of subsequent investigation; proving arsenic, if it exists at all, to exist in such diminutive proportion that visible marks of its presence could not be obtained by heating the mineral on charcoal or in a glass recipient.* Notwithstanding the differences detailed above, the actions of chlorhydric acid, of alcohol, and of bisulphate of potash give evidence of the notable difference between eosite, Descloizite, and vanadite, and of the nearly absolute identity of the two varieties of vanadite from Kappel.

Small splinters of both these varieties, moistened with chlorhydric acid on glass plate, become yellowish grey on their margins, the internal portion assuming a dark reddish-brown tint. Under the protracted action of the acid this nucleus becomes darker and lessens in size, till at last it disappears, leaving a portion of uniformly greyish white substance. The nucleus of the carnation variety, B, shows a somewhat lighter tint in the beginning; this difference, however, vanishes more and more under the lengthened action of acid; alcohol added to the cold solution of both varieties, provokes the secretion of a yellowish green gelatinous substance, which, being heated to evaporation, leaves on the glass plate a precipitate of fine green colour.

These alterations are common to both varieties, as also those provoked by fusion with bisulphate of potash. The saline substance thus obtained is yellow during fusion; it becomes reddish during cooling, and deep reddish orange after complete refrigeration. This last colouration may exceed two or three times in intensity the colouration obtained by treating eosite with bisulphate of potash.

These experiments, merely tried with some few minute fragments, although anything but decisive, are sufficient for ascertaining the difference between eosite and the vanadates of lead.

As the dark variety (A) resembles Peruvian eosite, the light variety (B) bears some resemblance with the Dechenite from Schlettenbach.

This Dechenite is likewise of carnation colour, somewhat fainter on the surface than on the recent fracture. The cabinet specimen before me shows isolated crusts, transversely concreted, with globular external surface, offering a black berry-like aspect. A fracture shows these crusts to be concentric agglomerations of minute crystals (1 m.m. in size), externally exhibiting only one or two of their planes. Isolated margins may be found out by careful inquiry, but I could not succeed in obtaining any measurable angle. The crystaline crust includes a number of spheroidal cavities (similiar to those of pisolite), around which the aggregations of crystallised Dechenite are concentrically disposed. Greenish pyromorphite appears on the inferior surface of the specimen in question.

Like the variety β of vanadite, this specimen is very easily affected by moisture. Even when a sheet is held before the mouth, the moisture of the air breathed out is sufficient to provoke globular yellowish-grey efflorescences. The streak is orange, verging into reddish-brown.

The action of chlorhydric acid and bisulphate of potash is nearly the same with that exercised on vanadite, as already detailed.

A splinter moistened with chlorhydric acid shows a yellow margin and a darker nucleus, in which the vanadium is concentrated. The colour of this nucleus, instead of being very intensely brownish red, is of a rather darker brown than the unaltered mineral. The action of the acid manifested by the progressive darkening and lessening of the nucleus is, however, less prompt and less evident than when vanadite is acted upon, and resembles rather the alterations undergone by eosite. The difference lies, however, in the yellowish colouration of the solution around the crystal lying on the glass plate. Alcohol gives rise to the secretion of a gelatinous yellowish-green liquid, which, evaporated by heat, assumes a fine green or bluish-green tint, nearly identical to the tint assumed by vanadite under the same circumstances.

Dechenite, melted with bisulphate of potash, gives a deep brownish-yellow substance, reddening by cooling out, and finally becoming of a deep orange. This salt, heated in a platinum spoon with laminated tin, gives a faintly greyish-green solution.

The analogy between the vanadate of lead from Schlettenbach (Dechenite) and the vanadate from Windisch-Kappel (vanadite) goes still beyond their chemical characters. I submitted both these minerals to the action of the blowpipe, in order to find out, independently from my comparative studies concerning eosite, the cause of the prompt decomposition of the cabinet specimens from both these localities.

A splinter of Dechenite from Schlettenbach, heated in a glass recipient, emits, previously to its melting, a greenish-white vapour, not condensing into water drops nor in any other precipitate, upon the cooler portions of the recipient. The presence of arsenic is manifested neither by its characteristic smell nor by any specular sublimate. The mineral takes a darker tint when heated, and assumes again its original tint by cooling. It melts in the glass recipient, without previous decrepitation, into a brownish-yellow substance. Heated on charcoal, Dechenite melts easily, and with ebullition into a hollow dark steel-brown globule, giving at the same time a slight orange aureola and a whitish slag, including metallic granules. Melting with soda gives rise to a yellowish slag, including granules of metallic lead, and to graphitic vanadium imbedded in the charcoal. The slag imbibed with cobalt solution and heated to redness, assumes an unclean greenish tint and is surrounded by a greenish-yellow aureola, thus betraying the presence of a rather notable quantity of zinc, not mentioned in M. Bergemann's account of his analysis of Dechenite.

Among the vanadites from Kappel, only the carnation variety, B, seems to contain a notable proportion of zinc. Its tint darkens transitorily during heating, emits a faint vapour (of water) when heated in a glass recipient, without manifesting the presence of arsenic, and melts on charcoal into a dark greyish-brown, steel-bright globule, proving hollow when the flame of the blowpipe touches it. A notable aureola of oxidated lead appears, together with a small quantity of a dark slag, including globules of lead and graphitic vanadium, and assuming a green tint in contact with nitrate of cobalt or cobalt nitrate.

The darker variety, A, exhibits the same phenomena when heated in the glass recipient or by the blowpipe-flame, only the remaining slag is dark coloured, and only in one case among repeated experiments I could perceive on it some faint traces of green colouration. Possibly this variety may contain but a small proportion of zinc, as M. Damour has found only 2½ per cent of this metal in the Peruvian Descloizite.

The result of the before-detailed investigations, leaving previously aside the subsequent crystallographical facts, may be reassumed as follows:—Of both the varieties of vanadite from Kappel, the darker one (A) contains but a small proportion of zinc, and may be assimilated to the Peruvian Descloizite; the lighter one (B) is far richer in this metal, and may be identified with the Dechenite from Schlettenbach. Eosite differs from both these minerals as to its chemical characters.

Discussion of Results.

The morphological properties run parallel to the chemical characters of the minerals here in question. The results obtained may be concisely enounced thus:—

The crystalline form of eosite differs from those of Descloizite and Wulfenite, having the terminal lateral

* Several experiments intended for ascertaining directly the chemical character of these efflorescences remained without any satisfactory result.

angles of Descloizite united with crystallographical system of Wulfenite.

Eosite is a vanado-molybdate of lead.

The red varieties of Wulfenite have an admixture of chrome, but are not crystallographically different from the other varieties.

Descloizite is isomorphous to Anglesite; thus the results of the analysis of Descloizite seem to be questionable.

The dark variety of vanadite (A) from Kappel is identical to Peruvian Descloizite; the light variety (B) from the same locality is nearly identical in chemical characters to the Dechenite of Schlettenbach, and, as to the form of its crystals, to Descloizite.

These appear to me to be the result of the present investigations. They are still incomplete as to the crystalline forms of Dechenite. I would, however, congratulate myself if the hints given in their exposition could provoke some more attention for finding out distinctly crystallised groups of Dechenite.

TECHNICAL EDUCATION FOR THE SONS OF FARMERS.

MR. LITTLE has forwarded us a letter on this subject written to the members of the "Lincolnshire Farmers' Association," and other Agricultural Associations in Great Britain. In it he says—

It is indeed surprising that in a country where the practice of agriculture is carried to such a high degree of perfection, and where it is one of the chief sources of wealth, and is besides the means of employing such an immense amount of labour and capital, so little should be done towards the scientific education of those engaged in its pursuit. As a rule, agriculture is practised almost exclusively under the guidance of a slowly-earned experience, and mere traditional principles and habitual routine, without those engaged in it having any appreciation of the phenomena and natural laws which govern the growth and production of animal and vegetable food, the first necessities of man.

The success we have already arrived to in agriculture is, I believe, more mechanical than scientific. Drainage, steam culture, and a liberal use of capital and labour, are amongst the chief causes; but now that chemistry in its relation to artificial manures is taking such a prominent position, it is of the first importance that the future generation of farmers should have such a general knowledge of science as will enable them to correctly appreciate the value and properties of the various compounds offered by the too numerous chemical manure makers.

I cannot imagine a more dangerous, unfortunate, and lamentable position for any person to be in, whilst in the practice of his business, by which he hopes to gain his bread for himself and family, than being entirely dependent on the scientific skill and integrity of another man; or that his capital, time, labour, care, and hopes should be in many cases completely out of his own control. Such a state of things cannot—must not—last.

What I propose to do to correct this state of things is this—at a very moderate cost to give to an agricultural pupil a six or twelve months' course of scientific education and practical laboratory teaching after he has left his regular school; and I will engage that any boy of average ability, at the expiration of this time, shall have such a knowledge of all the materials employed in the compounding of chemical manures as will enable him to dictate what should be used without the interested interference of the manure maker. He shall, besides, have such an insight into the science and laws of chemistry as to make the reading and future study of scientific agriculture not only perfectly easy, but a delightful and intellectual employment.

To carry out this important object three conditions are necessary—a good qualified teacher, a laboratory, and pupils. The first could be had for a very moderate salary; the laboratory, with the necessary instruments and materials, would involve no serious outlay; the third condition, the pupils, gives rise to this question—would farmers send their sons to supplement their previous education by a six or twelve months' practical scientific instruction? The want of such knowledge amongst the present generation must be so strongly felt that I believe they would be too glad to have the opportunity, especially if they knew that probably a moderate fee would more than pay the costs.

The site of the laboratory might be anywhere—a small country village would in many respects offer advantages superior to a market town. The cost of erecting or hiring a building suitable for a laboratory, together with the instruments and materials, should be raised by subscription. The pupils' fees would, I have no doubt, pay all other charges, so that when once established it would ever after be self-supporting.

I am aware that certain schools exist where agricultural science is professedly taught, but I consider such a combination as almost waste time, the two kinds of teaching cannot be well carried on together, and what is most important, the mind must arrive to a certain maturity before it can grasp with sufficient reasoning power, the beautiful and wonderful phenomena arising out of laboratory practice.

If the foregoing observations should be thought worthy of the serious consideration of persons interested in agriculture, I shall indeed be glad to receive any communications or suggestions in promotion of the object of this letter; and if our members will support this object by the subscription of a sum equal to only a tenth of one year's savings effected through the agency of our association, I will devote myself most earnestly to establish a school laboratory in this village that I trust may serve as a model and example to be followed by many other localities in Great Britain.

I shall certainly not ask a single member of our Association to do that which I am not prepared to do myself. My consumption of phosphate manure—of course, I buy no mixtures or nostrums—is about twenty tons a year; and previous to the formation of our Association I paid to the most respectable makers £6 10s. per ton for manure containing 25 *per cent of water*. The percentage of soluble phosphate was entirely a matter of speculation; according to an elaborate report of Anderson and Way, from an analysis of 171 samples, the average percentage of soluble phosphate at that time was 15 per cent, and a ton of this manure was valued by these chemists at £7 5s. per ton. Therefore, if a 15 per cent manure was worth £7 5s., a 26 per cent manure would be worth £12 10s.; but our Association price for the 26 per cent manure is now £3 18s. per ton in bulk, delivered free at any station in Lincolnshire, with a further advantage of a watchful system of analysis, free of any cost, to ensure quality and dry condition.

My saving on these calculations would be £8 12s. per ton, or a total of £172 on a consumption of twenty tons yearly. I state facts just as they are recorded by the most eminent chemists, and every farmer will believe me when I say that a very large proportion of the manure sold at that time had little or no value whatever, consisting as it did of *dried mud and road scrapings*, flavoured with a little gas water just to flatter the olfactory nerves of the wise and cautious farmer of that period. A tenth of £172 would be £17 4s. for my contribution, but my requirements are much more modest. I think, therefore, I had better leave every member of our Association to form his own estimate of what he should contribute, suffice it to say that in the first instance the only contribution I ask for is a free and unprejudiced opinion as to the necessity and desirability of what I have in view—viz., the formation of a laboratory, in which agricultural

chamistry shall be taught at small cost, in a short time and in a practical way, to pupils who have received an ordinary education.

I have only alluded thus far to the material advantage to be derived from a brief course of scientific instruction. Allow me, in conclusion, to quote the language of one of the best and most highly gifted of our chemical philosophers as to its moral influence. The late Dr. Faraday says—"I do think that the study of natural science is so glorious a school that with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter, there cannot be a better school for the mind." Vain and foolish ideas, the fruit of ignorance, cannot be uprooted and destroyed by violence, the natural and more gentle method must be adopted, what in chemistry is called the law of substitution; the mind must be fertilised by knowledge, then truth and useful ideas will take the place of error and ignorant conceits. It is the absence of the exercise of the higher and intellectual faculties that leads so often to vacuity of the human mind, and the consequent indulgence in grosser and more material excitements, injurious alike to body and mind. A better form of education would eradicate the greatest of all human enemies—Ignorance and Intemperance.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

May 18th, 1871.

Professor FRANKLAND, F.R.S., President, in the Chair.

Messrs. T. Greenish, and J. E. Mayall were elected Fellows.

The following papers were read:—

"*On a New Double Salt of Thallium*," by R. J. FRISWELL.

The author, wishing to prepare thallic platinocyanide, mixed hot solutions of thallic carbonate and potassic platinocyanide, and obtained, on leaving the mixture to cool, masses of splendid crystals, which appeared by transmitted light of a magnificent crimson-red, whilst their reflected colour was a bronzy green of strong metallic lustre. On treating these crystals with acids, they effervesced, evolving carbonic acid, and leaving a pale pink residue; thus showing that the salt was not the desired double cyanide. The thallic platinocyanide is obtained by decomposing baric platinocyanide with an equivalent quantity of thallous sulphate; it is yellowish-white and completely destitute of dichroic tints. The analysis of the first-mentioned salt suggests it to be a compound of thallic carbonate and thallic platinocyanide,—

$$Tl_2PtCy_4,COTl\Theta_2.$$

When the residue, obtained after treating the salt with nitric acid, was washed, dried, and analysed, it gave figures corresponding to those required by theory for thallic platinocyanide. The precise form of the crystals has not yet been determined, but Mr. Friswell, believing the thallic platino-cyano carbonate to be a true double salt, supposes that it belongs to the trimetric system, since thallic carbonate and thallic platinocyanide belong to that system, and it is generally assumed that a double salt is isomorphous with its constituent salts. Mr. Friswell uses the term true double salt to denote a molecular combination and not a body of a more complicated nature like an alum.

In the following discussion the PRESIDENT remarked that he considered the new salt as an atomic combination, the platinum affording the link between the thallic cyanide and the thallic carbonate.

Professor WILLIAMSON, too, regarded it most probable that so great a number of atoms were bound together by atomic forces.

Mr. SPILLER inquired whether the thallium was disguised in the salt, or whether it gave the usual reactions? which question the author answered affirmatively in the latter sense—it gave all the known thallic reactions.

The next paper read was "*On the Action of Nitric Acid on Dichlorophenol Sulphuric Acid*," by Dr. ARMSTRONG.

CORRESPONDENCE.

ATOMIC BONDS.

To the Editor of the Chemical News.

SIR,—With reference to the discussion raised at the last meeting of the Chemical Society on the above subject, may I be allowed to adduce the instance of the use of lines, to mark direction and intensity of force, in that department of science which treats of mechanics?

The ease with which, by means of these symbols we are enabled to solve such problems, for example, as the composition and resolution of forces, is an argument for the use of similar symbols in giving graphic representations of the forces acting between atoms.

No one supposes that when two or more forces undergo composition or resolution, a visible, tangible, parallelogram, with its diagonal, exists, except upon paper; nor need we fear that the young chemist, unless of unusual dullness, will attach any more reality to the "bonds" which express the attraction of atoms.—I am, &c.,

B. J. G.

May 22, 1871.

GRAPHIC FORMULÆ.

To the Editor of the Chemical News.

SIR,—In the conversation which took place at the Chemical Society on Thursday last after the reading of Dr. Armstrong's paper, a discussion on graphic formulæ arose.

Dr. Williamson objected strongly to the materialistic idea which he asserted was induced by the use of "bonds" between symbols in a graphic formula. He made use of an alternative method and took for his example benzole, C_6H_6, which he represented thus—

H | H | H
C C C
C C C
H | H | H

This is supposed to be represented in space instead of on a plane surface, and to be a closed chain or triangular prism.

The objection to the bonds I think applies equally to this for if the bond produces the idea of a "strap or wire," surely the lines between the hydrogen atoms suggest a "wall" around or between them.

Either of these ideas, if they were produced, would be equally objectionable, and the only remedy would be to reject alike bonds and walls, and write graphic formulæ without either.

Any one who has had any experience in teaching can at once see what confusion this would entail. Even in memoirs and lectures it would be almost impossible to convey a real and definite idea of the constitution of many bodies, and, as a result, the present well-defined theory of "atomicity" or equivalence would give way before a sort of polyatomic theory in which every atom could combine with an unlimited number of like or unlike atoms, a result

which one cannot but feel would be attended by disastrous consequences in all attempts at teaching.

If, as I think is the case, wall or bond must be used, bond is certainly the best, for it represents a positive proposition, *i.e.*, that no combination exists.

I would respectfully submit to Dr. Williamson that a positive proposition is always to be preferred to a negative, —at any rate in teaching; firstly, because in the majority of cases it is more important as a fact; secondly, because a positive proposition is always more easily grasped and retained by the mind upon which it is impressed.—I am, &c.,

R. J. F.

PS. Is not the representation of a graphic formula in space making an assumption as to its form, and therefore more materialistic than merely writing down symbols on a plane surface?—R. J. F.

INTERMITTENT SPRINGS.

To the Editor of the Chemical News.

Sir,—Being at Buxton a few days ago, an excursion party was formed to visit the Peak Cavern, at Castleton. On our way thither, the "driver" suddenly pulled up and called our attention to a small "pond" by the roadside, into which was running a clear stream of water, which came out of a hill of considerable altitude, along the side of which hill the road ran.

Being thus admonished we all alighted, and were then informed by the "driver" "that the water of the spring intermitted, and that it was considered one of the 'wonders' of Derbyshire; that just as we arrived, he observed the stream had begun to flow; he added that he often brought visitors to see it, who had sometimes (like visitors to the Great Geyser in Iceland) to wait several hours to witness the flow and intermission of the stream."

On looking at the water, it at first seemed as if the stream was constantly running into the pond, and out at the other end, by a channel under the carriage road, till I observed that the stones in the pond began to be covered with the water, just like it is when the tide on the sea shore comes in. This showed that the "water level" of the pond was rising.

I then went to the other side of the pond and observed that the water came out of the hill on, or just below, the level of the surface of the pond, and a good deal seemed to rise from somewhat further below the surface.

The pond now became much fuller, and I should judge that the flow of water, while we watched it, was from 500 to 1000 gallons. The "driver" then informed us that the stream from the hill was about to stop, which, to our great surprise, it certainly did, and the surplus water draining out of the pond, the stones again appeared above the surface of the water, and all was still.

On considering the matter, the first impression on the mind was that some one high up the hill had opened a "flood gate" to let water run down to the pond, and then had suddenly shut it, but on looking at the hill no such hydraulic apparatus was visible.

The hill is composed of mountain limestone, and on attentively considering the matter, it occurred to me that the explanation of the phenomena is as follows:—

The limestone is full of cracks and hollows: when the rain falls on the hill it drains down in many channels, which all meet at a large hollow cavity, high up the hill. This cavity being cup-shaped, and impervious to water at the bottom, would accumulate in its interior a large body of water.

We have only then to imagine a channel rising up from the pond up the interior of the hill, which channel would be formed in the rock, going over the highest level of the water in the cavity, and the opening of the channel descending below the level of the water to the bottom of the cavity, exactly on the principle of the syphon, and the whole matter is explained.

Thus, suppose the cavity is empty—after a heavy shower of rain it slowly fills; if the supply continues, the water will rise "above" the level of the bridge of the syphon, and if there is sufficient water overflowing to perfectly fill the "longer leg" which goes down to the pond, the pressure of the atmosphere on the surface of the water will push all the water out of the cavity down the syphon, which water will then appear as a good stream running into the pond. When all the water has run out of the cavity, the stream of course ceases.

In very dry weather, if the supply of water was but just sufficient to keep the cavity full, and not enough to perfectly fill the "longer leg," the surplus water would slowly trickle over the bridge, without starting the syphon, and the stream being very small would not be observed; hence visitors may go to see the spring commence running and be disappointed. On the other hand, if it is very wet weather, there may be sufficient water to fill the syphon, and thus keep the spring constantly running without emptying the upper cavity.

The most favourable time to see the commencement and intermission of the stream should be in moderately dry weather, when there is sufficient water in the cavity for the syphon to draw off two or three times a day.

It requires some little "tact" to make a syphon which shall start itself, and it is certainly very remarkable, that by the natural crevices, channels, and cavities, contained in the mountain limestone a self-acting syphon should be formed on a somewhat grand scale.

How long this intermittent spring has been running can only be guessed at, but I observed that there are in the pond some "worked stones" which form a sort of sunk trough into which the spring runs out of the hill; this trough looks very old, and has no doubt been there for ages.

There is a "tumulus" on a neighbouring hill, and the ancient military earthwork on "Mam Tor" is not far distant.—I am, &c.,

Alfred Bird, F.C.S.

Birmingham, May 18, 1871.

ATOMIC VOLUMES.

To the Editor of the Chemical News.

Sir,—It is generally assumed in modern chemical works, that the weights of the atomic volumes of the elements, with certain rare exceptions, such as arsenic and phosphorus, are the same respectively as their combining weights. Thus, for instance, Dr. George Wilson, in his useful little treatise on "Inorganic Chemistry," observes that "an atom of hydrogen, or 1, taken as unity, will occupy, a volume or measure represented by a single square; an atom of chlorine, or 35·5, will be exactly enclosed in the same measure or square; an atom of oxygen, or 16, will only fill the same volume or square; and so in the case of the atom of nitrogen, 14, and the atom of carbon, 12."

When, however, we consider attentively the constitution of compound gases, we shall find that many difficulties are involved in the theory thus enunciated. Let us take, for example, hydrochloric acid, HCl, formed, without condensation, of one atomic volume of hydrogen, 1, and one atomic volume of chlorine, 35·5. Now, as each of the two volumes thus produced must contain both hydrogen and chlorine, it follows that both the single volumes of these gases are in the combination halved, or equally divided, otherwise an uniform double compound volume could not result.

Again, in the case of water, H_2O, we have two atomic, volumes of hydrogen, 1, combined with one atomic volume of oxygen, 16; forming two volumes of aqueous vapour. Here the single atomic volume of oxygen, like the H or Cl in HCl, must have been divided into two to become a constituent of the normal product volume represented by H_2O.

As another simple illustration, I may refer to ammonia, H_3N, formed of three atomic volumes of hydrogen, 1, and one atomic volume of nitrogen, 14, condensed into two compound volumes. Applying similar reasoning, we infer that the single atomic volume of nitrogen thus combined must also be halved or divided, both the volumes of H_3N containing this element. Indeed, we might even conceive the atomic volume of nitrogen in H_3N to be divided into three parts, inasmuch as it is chemically and equally associated with each of the three atomic volumes of hydrogen. But, at least, we seem, as I have said, to be justified in regarding the N atomic volume as divided into two in the compound double volume H_3N.

These considerations naturally lead to the conclusion that the so-called atomic volumes are strictly multiples of the true combining elementary volumes; in other words, that in order to form the double standard compound volume, the atomic volumes must, generally speaking, be halved or divided, and that, consequently, the numbers representing the weights of such combining elementary volumes should be really the *halves* of those that now represent the atomic volume weights or the respective combining weights.

This theory does not in the least affect the proportions by weight in which the volumes, erroneously according to it termed *atomic*, unite, seeing that in the case of hydrochloric acid, for example, we have only to consider the present atomic volume weights of the hydrogen, 1, and of the chlorine, 35·5, as denoting double the elementary or *true* atomic volume weights.

Hoping that these few and imperfect observations may lead to further inquiries concerning that important and interesting subject, the combination of gases—I am, &c.,

W. H. O.

Mildmay Road, Stoke Newington, May 19, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

American Journal of Pharmacy, May, 1871.

This number being the first published under the editorship of Dr. J. M. Maisch, who has succeeded Mr. Procter, we must not omit to compliment the new editor, and express our sincere wish that he may earn as great a success as his excellent predecessor, and, like him, hold this important post for a long series of years. In addition to a series of papers, the contents of which relate strictly to pharmacy, we meet in this number with the following original papers and memoirs bearing upon chemistry:—

Preservation of Pharmaceutical Apparatus from Breakage by Change of Temperature.—R. Simpson.—The contents of this paper, which contains the detailed account of a series of experiments made by the author, may be briefly summarised as follows:—Every one is aware that the pouring of hot liquids into thick glass vessels is frequently attended with the breakage of the same. The author states that, if metallic rods are so placed in these vessels that the rods do not touch any part of the sides thereof, and the hot liquid poured alongside the rods, no breakage takes place, owing to the absorption of heat from the liquid by the rod, which, to ensure success, should be placed on the centre of the bottom of the vessel and be held perpendicularly. The thickness of the rods should be about ¼ of an inch, and the metal they are made of may vary to suit the quality of the liquid—iron, brass, copper, glass, but the latter must be used with great care, on account of their inferior absorbing power.

Preservation of the Oils of Oranges and Lemons.—C. Fruh.—The author adds to every pound of oil 1 oz. of pure alcohol, which, having been thoroughly mixed with the oil, there is added to it 1 oz. of water, which again withdraws the alcohol from the oil, and collects at the bottom of the bottle as dilute alcohol. The *rationale* of this process appears to be that the alcohol, by removing foreign resinous and other matters present in the oil, retards the oxidation of the oil by the atmosphere; but the author is engaged in further elucidating this point by continuing a series of experiments on this subject.

Uva Ursi.—Dr. J. Jungmann.—This essay contains an account of the author's researches on this well-known material, the leaves of the *Arctostaphylos uva ursi*, the bear-berry. After reviewing the botanical description of the tree which yields this drug, and other matters strictly belonging to *materia medica*, the author reviews the analyses made since 1809, and then exhaustively relates his own experiments, and the mode of preparation and properties, first of arbutine, discovered in 1852 by Dr. Kawalier. The most prominent feature in relation to this glucoside is a remarkable test the author discovered for its detection. When a solution of arbutine in water is rendered alkaline by ammonia or any other caustic or carbonated alkali, and then phospho-molybdic acid is added, a blue colour is produced. In strong solutions, the colouration is of a deep azure blue, but the bluish hue can be observed even in very dilute solutions (1 in 140,000). This reaction does not occur with molybdate of ammonia, nor does it take place when phosphoric or phospho-molybdic acid is acted upon by an alkali alone. From the mother-liquor of arbutine, when heated with a dilute acid (sulphuric or hydrochloric), a resinous body separates, ericolin; also a glucoside, which, when treated with a dilute acid, splits into grape sugar and an odorous substance having the character of a volatile oil. Ericolin is a dark brown resin, becoming somewhat lighter when dried and rubbed to powder; its chemical composition is $C_{68}H_{66}O_{32}$; its decomposition into ericinol is exhibited by—

$$\underbrace{C_{68}H_{66}O_{32}}_{\text{Ericolin.}} + 8HO = \underbrace{C_{20}H_{16}O_8}_{\text{Ericinol.}} + \underbrace{4C_{12}H_{12}O_{12}}_{\text{Grape sugar.}}$$

The folia *Uvæ ursi* are found to contain the following organic constituents:—Arbutine, decomposable into hydrokinone, ericolin, ericinol, ursen, tannic, gallic, and malic acids, a small quantity of volatile oil, fatty matter, wax, gum, sugar, albumen, colouring matter, and cellulose.

Crab-Orchard Salt.—J. T. Viley.—This salt is obtained from the waters near Crab-Orchard, a small town in Lincoln County, Kentucky. The most interesting part of this lengthy paper are the results of the analysis, viz.:—Sulphate of magnesia, 44·778; sulphate of lime, 1·277; sulphate of potassa, 1·871; sulphate of soda, 6·483; chloride of lithium, 0·049; chloride of sodium, 0·412; water, 44·655; insoluble matter and ferric oxide, 0·520. Dried at 120°, the salt contains—Water of crystallisation, 18·933; sulphate of magnesia, 65·463; sulphate of potassa, 2·735; sulphate of soda, 9·480; chloride of sodium, 0·602; chloride of lithium, 0·072.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 6, 1871.

This number contains the following original papers and memoirs:—

Hydrate of Sulphide of Carbon.—Dr. Ballo.—This paper is a refutation of the assertions made by M. V. Wartha against the correctness of this author's researches; but it does not contain anything new on the above-named subject, the author's further researches in that direction not having been completed.

New Series of Aromatic Hydrocarbons.—Dr. T. Zincke.—After first referring, at some length, to a series of investigations made some years ago on the action of finely-divided copper upon benzyl-chloride, the author in this paper states that, by treating benzol-chloride and benzol, first with finely-divided zinc, and next employing fractional distillation, he obtained a new hydrocarbon, exhibiting an orange-like smell, consisting of $C_{13}H_{12}$, crystallising; fusing at 25°; boiling and distilling over, without decomposition, at 262°; readily soluble in alcohol, ether, and chloroform. With bromine it yields a substitution compound, while it yields a nitro compound with strong nitric acid, and on being oxidised, which it does with great difficulty, it yields, along with some benzoic acid, a substance of the same composition as benzo-phenon. Toluol and benzyl-chloride yield, in the same manner, a hydrocarbon boiling at 277°. This new body is, as regards its properties, very similar to that just alluded to, but it is a fluid (sp. gr. 0·995 at 17°). The structural formula of the first-named hydrocarbon is $C_6H_5-\cdot\cdot-CH_2-\cdot\cdot-C_6H_5$, while the structural formula of the second is $C_6H_5-\cdot\cdot-CH_2-\cdot\cdot-C_6H_4-\cdot\cdot-CH_3$.

Constitution of Alizarine and Naphthazarine.—M. T. Petersen.—Notwithstanding the high scientific value of this essay, it is not possible to give any further notice of it here, because for the due understanding of the contents it would be requisite to reproduce a lengthy and very complex series of formulæ, which our space forbids us to do.

Heat of Neutralisation of the Inorganic and Organic Bases Soluble in Water.—Dr. J. Thomsen.—Among the results obtained by the researches described in this lengthy essay we quote the following:—Lithium, sodium, potassium, and thallium, when dissolved in water in the state of hydrates, yield, when neutralised with sulphuric acid, almost identically the same quantity of caloric, the average number for the four being 31,130 c., and no greater difference exists between the values of the four figures than 5 per mille. As regards the alkaline earths—baryta, strontia, lime, magnesia—the average number is 31,140 c., and the difference between the four figures is even less than in the former case. Consequently, the author draws the following conclusion:—That the molecule of sulphuric acid yields, by neutralisation with the alkalies and alkaline earths, a quantity of caloric which is almost precisely the same, and amounts, on an average, to 31,134 c. The paper further treats on ammonia and compound ammonias, in relation to the quantity of heat they yield by neutralisation with acids.

Caloric Action of Water.—Dr. F. Mohr.—The main object of this exhaustive memoir is to prove that what the author has set forth as the mechanical theory of chemical affinity holds good, and is applicable for the explanation, also, of the phenomena observed when salts are dissolved in water, that is, according to the author, have combined with water. When water, while combining with bodies, obtains a higher temperature, the boiling-point of the water has risen; but when water, by combining with a body, has become lowered in temperature, the freezing-point of water has been lowered. The author speaks in this paper of a large work on the subject here referred to, and published by him, but he does not quote the title.

Contribution to the History of the Benzol-Sulpho Acid.—M. Ascher and V. Meyer.—This paper treats on what is here termed Schmitt's benzol-sulpho acid, obtained from the diazo derivative of sulphanilic acid, according to the following formula:—

$$C_6H_4\begin{Bmatrix}SO_3\\ \diagdown\\ N{=}{=}N\end{Bmatrix}+C_2H_6O=C_2H_4O+N_2+C_6H_5SO_3H.$$

The authors, having prepared the benzol-sulpho acid referred to from the diazo-derivative of the sulphanilic acid, proceed to record, in this paper, a series of results of experiments, all of which tend to refute the opinion expressed by M. Schmitt, that the benzol-sulpho acid obtained by him, and above referred to, should not be identical with the ordinary benzol-sulpho acid. This identity is proved by the composition of the potassa salt, the chloride, the amide, the anilide yielded by the acid under investigation, and lastly, also, by the solubility in water, both benzol-sulpho acids dissolving at 16 in 1000 parts of water to the same extent.

Application of the Spectroscope for the Quantitative Estimation of Colouring Matters.—M. K. Vierordt.

On Hæmatoxyline.—Dr. F. Reim.—From this lengthy monograph we quote the following main results of the author's researches on this subject:—Hæmatoxyline is not a body constituted as phloroglucin, but it is a derivative of the so-called aromatic series. Towards weak oxidising agents it behaves as a hydrochinon, since the hæmatine which is formed stands to the hæmatoxyline in the same relation as the chinon does to hydrochinon. Lastly, hæmatoxyline contains six hydroxyl groups. The structural formula for hæmatoxyline is—

$$\begin{array}{l}C_6H_3(OH)_2\\ \quad|\\ \quad|\\ C_4H_4\\ \quad|\\ \quad|\\ C_6H_4(OH)_4\end{array}$$

and the similar formula for hæmatine is—

$$\begin{array}{l}C_6H_3(OH)_2O\\ \quad|\\ \quad|\\ C_4H_4\\ \quad|\\ \quad|\\ C_6H_4(OH)_4O\end{array}$$

A Solvent for Indigo-Blue.—Dr. V. Wartha.—The author states that Venetian turpentine, heated to its incipient boiling-point, is a solvent for indigotine, which, after cooling, is readily purified by the aid of ether or alcohol. Boiling paraffin also dissolves indigo-blue (indigotine), and the paraffin can be removed, after cooling, by means of benzol. Spermaceti, stearic acid, and chloroform, all at a high temperature, are stated to be more or less good solvents for indigo.

On Benzoine.—Drs. Limpricht and Schwanert.—The contents of this paper records a series of experiments on the action of alcoholic potassa solution upon benzoine, and the formation of benzilic acid as an effect of the simultaneous action of the atmosphere, since in sealed tubes only benzil is formed. The formation of ethyl-dibenzoine and acetyl-ethyl-dibenzoine from benzoine is elucidated by a series of lengthy and complex formulæ; while, lastly, the generation of oxylepiden from benzoin by the action thereupon of hydrochloric acid in sealed tubes is explained.

Lecture-Room Apparatus.—J. Y. Buchanan.—And on the—

Formation and Decomposition of some Chlorited (Chlorirten) Acids—J. Y. Buchanan—Are papers which cannot be well abstracted, since to both are added diagrams and woodcuts.

Chemical and Mechanical Change of the Haloid Salts of Silver under the Influence of Light.—C. Schultz-Sellack.—The author communicates a series of experiments made with the object of proving that, while the chloride, bromide, and iodide of silver are acted upon by light, and altered in a well-known manner, this action is due to a phenomenon of dissociation, called forth by the light; but when these salts are put in sealed tubes, and care taken to have an excess of the haloids in free state present, and the tubes exposed to light, a mechanical change is effected, since the previously crystalline salts—obtained in that state from the ammoniacal solutions of the chloride and bromide and hydriodic acid solution of the iodide of silver—become at first turbid, and next crumble to powder. This mechanical change of the haloid salts of silver is greatest when the chemical change is smallest.

Formation of Lactic Acid from Sugar without Fermentation.—F. H. Seyler.—After first referring to the action of caustic alkalies, aided by heat, upon grape sugar, cane sugar, milk sugar, and cellulose, the author states that when 1 lb. of grape sugar is placed, along with half a litre of caustic soda solution (1·34 sp. gr.) in a capacious retort, an equal volume of water added, and the retort heated in a water-bath, a very strong reaction sets in at 96°, the temperature rises to 116°, the mixture boils violently, and, though no gas is evolved, a pleasant smell ensues. If, after the exact neutralisation of the soda by means of sulphuric acid, the liquid is concentrated by evaporation, and next treated with ether, that fluid takes up, among other substances, lactic acid, which is removed from the ether by shaking it up along with water and carbonate of baryta, and purified by being converted into lactate of zinc.

Review and Critical Observations on the Essay "On the Products of Distillation of a Mixture of Butyrate and Acetate of Lime," published by Dr. F. Grimm.—Dr. A. Ladenburg.

Contribution to the Question on the System of the Elements.—Dr. D. Mendelejeff.—A review of the labours of Dr. Odling, MM. Gerstl, Blomstrand, L. Meyer, and others on this subject, as compared with suggestions and papers published thereupon by the author in Russian.

Phosphorus Compounds.—Drs. E. Drechsel and Finkenstein.—The authors describe at length the mode of preparation and properties of phosphide of zinc, obtained from an etherial solution of zinc-ethyl by the action of phosphuretted hydrogen. The body in question is exceedingly prone to decomposition, and can only be kept at a low temperature and in hermetically-closed bottles; it is a solid substance, and has been used by the authors for the purpose of preparing various organic phosphorus compounds, by means of double decomposition with chloride of acetyl, iodide of ethyl, iodide of methyl, and triethyl-phosphonium zinc iodide.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, March, 1871.

This number contains, in addition to some papers by Dr. A. W. Hofmann, the contents of which we have abstracted from other German periodicals wherein these papers have been also published, the following original papers bearing upon physico-chemical sciences:—

Action of the Secondary Currents (Nebenströme) of the Electric Battery on the Main Current and on each other.—Dr. Riess.—This memoir is divided into the following sections:—Counter action (*rückwirkung*) of a secondary current on the main current; counter action of two secondary currents upon the main current; action of two secondary currents upon each other.

Behaviour of Agate in the Magnetic Field, between the Poles of a Powerful Electro-Magnet.—Prof. Dove.—The author describes, in this paper, a series of experiments made with so-called mountain quartz and polished plates cut from agate, with the view to ascertain the diamagnetic properties of these minerals. It appears that all varieties of quartz exhibit unmistakably diamagnetic properties.

NOTES AND QUERIES.

Removing Sulphur from Coke.—Can any of your readers inform me of a process for the removal of sulphur from coke by steeping it in a solution of brine before ignition in the furnace, also giving the changes thereby produced.—R.

The New Solvent for Indigotine.—The use of aniline as a solvent for indigotine, as quoted in the CHEMICAL NEWS, vol. xxiii., p. 214, and in the *Journal of the Chemical Society* for the present month, from the *Ann. Ch. Pharm.*, is by no means a new discovery on the part of Drs. A. A. de Aguiar and A. Bayer. So far back as 1861 an editorial article in the CHEMICAL NEWS (vol. iii., p. 255) contains the following passage:—"Hot aniline dissolves indigo, forming a solution having almost exactly the tint of the solution of azaline in methylated spirit. On cooling, the indigo crystallises out in beautiful coppery spangles. This method of crystallising indigo from a solution in boiling aniline does not appear to be generally known to chemists." I have a strong objection to English discoveries being re-discovered on the Continent, and that is my only plea for encroaching on your valuable space.—R. MELDOLA.

MEETINGS FOR THE WEEK.

TUESDAY, 30th.—Royal Institution, 3. Rev. Prof. Haughton, "On the Principle of Least Action in Nature."
—— Civil Engineers, 8.
WEDNESDAY, 31st.—Society of Arts, 8.
THURSDAY, June 1st.—Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
—— Chemical, 8. Dr. Debus, "On Ozone."
FRIDAY, 2nd.—Royal Institution, 9. Prof. Andrews, on "Gaseous and
—— Liquid States of Matter."
—— Geologists' Association, 8.
SATURDAY, 3rd.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."

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THE CHEMICAL NEWS.

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FURTHER REMARKS ON BRITTLE SILVER.

By A. H. CHURCH, M.A.

I AM indebted to Mr. R. Warington for a reference to a note by his father on this subject. An analysis of a portion of a (Romano-British ?) silver urn (found near Bow, and weighing about 40 ounces) gave results which closely resembled those described by me in last week's CHEMICAL NEWS. The metal was, however, so thin that the whole substance of it had suffered a molecular change, and become crystalline and brittle. The late Mr. Warington interpreted the experimental results which he obtained exactly in the same manner as I do, attributing the brittleness of the silver to molecular disturbance, not to chemical change. He, however, did not separate the crust from the rest of the metal, and so obtained less conclusive proof of his view. If we translate his analytical numbers (*Mem. Chem. Soc.*, ii., p. 47, 1843) into percentages, after deduction of the silver chloride and ferric oxide which constituted the outer film of the object, they show the true metallic character of the brittle material.

Analysis of Brittle Silver, by the late Mr. R. Warington, F.R.S.

	Metal with crust. Per cent.	Metal crust deducted. Per cent.
Silver	90·01	96·74
Copper	2·83	3·03
Gold and loss	0·33	0·23
Silver chloride ..	6·12	—
Ferric oxide	0·71	—
	100·00	100·00

RESEARCHES ON THE HYDROCARBONS OF THE SERIES C_nH_{2n+2}.*

By C. SCHORLEMMER.

IN a former communication I have shown that the paraffins, the constitution of which is known, may be arranged in four groups. The first group, which I called *normal paraffins*, contain the carbon atoms linked together in a single chain. Of these I have obtained some new ones, which I shall describe more fully in a further communication. The normal paraffins which I have so far studied are given, together with their boiling-points, in the following table:—

	From petroleum.	From the acids of the series $C_nH_{2n-2}O_4$.	So-called alcohol radicals.	
C_5H_{12}	37°— 39°	—	—	
			Dipropyl.	From mannite.
C_6H_{14}	69°— 70°	69·5°	69°—70°	71·5°
C_7H_{16}	98°— 99°	100·5	—	—
				From methyl-hexylcarbinol.
			Dibutyl.	
C_8H_{16}	123°—124°	123°—124°	123°—124°	124°

That these paraffins have really the constitution which I have ascribed to them follows partly from their mode of formation; thus dipropyl was obtained from the normal propyl iodide, and dibutyl from normal butyl iodide. The constitution of the others was determined by converting them into alcohols and studying the oxidation products of the latter; thus the hexyl hydride from petroleum, as well as that obtained from mannite, was transformed into secondary hexyl alcohol, which on oxidation yielded acetic acid and *normal* butyric acid.

In the communication above referred to, I placed the hydrocarbon C_8H_{18} from methyl-hexyl carbinol amongst another group; but I have found now that this body is identical with dibutyl and also with the hydrocarbon, which Zincke obtained from primary octyl alcohol. This chemist prepared also dioctyl, $C_{16}H_{34}$, which consequently is a normal paraffin; and it appears probable that dihexyl, which Brazier and Gosleth obtained by the electrolysis of œnanthylic acid, belongs to this group too.

We are now acquainted with the following normal paraffins:—

	Boiling-points. Found (mean).	Calculated.	Difference.
CH_4	—	—	
C_2H_6	—	—	
C_3H_8	—	—	
C_4H_{10}	1°	1°	
C_5H_{12}	38	38	.. 37°
C_6H_{14}	70	71	.. 33
C_7H_{16}	99	100	.. 29
C_8H_{18}	124	125	.. 25
$C_{12}H_{26}$	202	207	.. 4×19
$C_{16}H_{34}$	278	278	.. 4×19

From this it appears that the boiling-point is not raised 31° for each addition of CH_2, as I formerly assumed, but that, as the calculated numbers show, the difference between the boiling-points of the lower members decreases regularly by four until it becomes the well-known difference of 19°.

* Read before the Royal Society, May 19, 1871.

ON THE SPECIFIC GRAVITY OF AQUEOUS HYDRIODIC ACID.*

By Dr. C. R. A. WRIGHT.

A SHORT time ago a note on the density of aqueous solutions of hydrobromic acid was communicated by the writer to this Society (CHEMICAL NEWS, vol. xxiii., p. 242): it appeared to be of interest to determine also the relation between the specific gravity and strength of hydriodic acid, so as to compare the three curves got with these two acids and also with hydrochloric acid.

Diluted hydriodic acid was got, in the first instance, by the action of sulphuretted hydrogen on iodine in presence of water; in this acid iodine was dissolved, and the whole digested at a very gentle heat with phosphorus; finally, the colourless liquid was distilled twice or thrice successively, the observations being made with the fresh distillate containing no traces of free iodine. The strength was found by a standard alkaline solution, and the specific gravity by weighing a known volume. The results, which only pretend to a moderate degree of accuracy, are as follow:—

Percentage of HI.	Sp. gr. at 15° C.
51·9	1·708
47·2	1·551
39·2	1·442
30·3	1·297
18·5	1·175
5·9	1·053

By graphical representation these numbers are found to agree tolerably together, yielding a *mean curve*, from which the following table is constructed;—

* Read before the Newcastle-upon-Tyne Chemical Society, March 23, 1871.

Percentage of HI.	Sp. gr. at 15°.	Difference for 5 per cent.	Difference for 1 per cent.
0	1·000	—	—
5	1·045	0·045	0·0090
10	1·091	0·046	0·0092
15	1·138	0·047	0·0094
20	1·187	0·049	0·0098
25	1·239	0·052	0·0104
30	1·296	0·057	0·0114
35	1·361	0·065	0·0130
40	1·438	0·077	0·0154
45	1·533	0·095	0·0190
50	1·650	0·117	0·0234
52	1·700	—	0·0250

From these numbers it appears, firstly, that the increase in sp. gr., as with hydrobromic acid, is not proportionate to the increase in strength; and, secondly, that the density of aqueous acid containing a given percentage, x, of HI is, as might be expected, greater than that of aqueous hydrobromic acid containing x per cent of HBr; this, again, being greater than that of hydrochloric acid containing x per cent of HCl.

The following table shows, comparatively, the sp. grs. of the three acids of different strengths, along with the values for hydrobromic acid calculated from the preceding formula:—

Percentage of Anhydrous Acid.	Specific gravity.			
	Hydrochloric.	Hydriodic.	Hydrobromic (found).	Hydrobromic (calculated).
5	1·0244	1·045	1·038	1·039
10	1·0488	1·091	1·077	1·078
15	1·0734	1·138	1·117	1·119
20	1·0981	1·187	1·159	1·159
25	1·1233	1·239	1·204	1·203
30	1·1484	1·296	1·252	1·249
35	1·1738	1·361	1·305	1·300
40	1·1966	1·438	1·365	1·356
45	—	1·533	1·435	—
50	—	1·650	1·515	—

It might, perhaps, be expected that the percentages of anhydrous acids, for the same sp. gr., would be in the inverse proportion of the atomic weights of the anhydrous acids, viz.:—

$$HCl = \frac{1}{36{\cdot}5} \qquad HBr = \frac{1}{81} \qquad HI = \frac{1}{128}$$

or taking the atomic weight of HCl as under:—

$$HCl = 1 \qquad HBr = 0{\cdot}450 \qquad HI = 0{\cdot}285$$

this, however, is not the case: thus the sp. gr. 1·050 corresponds to 10·2 per cent HCl, 6·5 per cent HBr, and 5·5 per cent HI, or HCl = 1, HBr = 0·64, HI = 0·54.

Similarly the sp. grs. 1·100, 1·150, 1·200 give the following ratios:—

Sp. gr.	Percentage of HCl.	Relative Percentage of HBr.	Relative Percentage of HI.
1·050	1·000	0·64	0·54
1·100	1·000	0·63	0·54
1·150	1·000	0·62	0·53
1·200	1·000	0·60	0·52

The preceding experiments were performed in the laboratory of Messrs. Bell Brothers, Washington.

ON SOME NEW DERIVATIVES OF ALBUMEN.*

By O. LOEW.

In regard to those derivatives or products of substitution of albumen, which stand nearly related to albumen, our knowledge is as yet very imperfect, and the principal radical complexes of the proximate constituents of albumen are not known at all. The difficulty of obtaining some insight into the composition of albumen is chiefly due to the facility with which albumen is split up, by different chemical agencies, into many simpler substances, as tyrosine, leucine, benzoic and caproic acids, or even uncrystallisable so-called extractive matters, of which it is difficult to obtain an exact chemical formula.

Some time ago, I endeavoured to obtain products of substitution of albumen, and at last succeeded in forming several derivatives, among them a nitro-product hitherto unknown. As regards the action of fuming nitric acid upon albumen, we only know that the latter is oxidised to an acid, called by Mulder xanthoproteic acid, for which, however, no exact formula has been given. In my experiments, a mixture of one volume of fuming nitric and three volumes concentrated sulphuric acid were employed. If less of the latter was used, an oxidation, in addition to the substitution, would occur.

30 grms. of finely-powdered albumen were gradually added to a cool mixture of 90 c.c. fuming nitric acid, and 270 c.c. concentrated sulphuric acid, shaking well after each addition, and taking care that the mixture remained cool. The albumen was slowly dissolved to a clear solution without any disengagement of nitrous acid fumes, and the solution, contained in a vessel surrounded by cold water, was, after a lapse of ten hours, poured into about fifteen times its volume of water. The voluminous flocculent precipitate resulting was immediately filtered, washed, lastly with hot water, and dried with care. The quantity obtained amounted to nearly two-thirds of the albumen employed; another part of the albumen is converted into a soluble product, which, after neutralisation of the acid filtrate, gives a precipitate with tannin.

The powder thus obtained is of a light yellow colour and a slightly bitter taste. It is insoluble in water, dilute acids, and alcohol, but is soluble in dilute alkalies, forming a reddish solution. On heating these alkaline solutions a decomposition begins and new products are formed, which I have not thus far examined. On heating the powder in a dry test-tube, it behaves like the original albumen, empyreumatic vapours being developed, accompanied by cyanogen, and carbon remaining behind.

On analysis, this new derivative yielded the following figures:—

I. 0·680 grms. gave 0·144 barium sulphate (determined by Kolbe's method) = 2·92 per cent sulphur.
II. 0·912 grms. gave 0·200 barium sulphate = 3·03 per cent sulphur.
I. 0·269 grms. gave 39·30 c.c. nitrogen at 741·5 m.m. barometer, and 9° C. = 17·20 per cent nitrogen.
II. 0·268 grms. gave 38·80 c.c. nitrogen at 742 m.m. barometer, and 9° C. = 17·00 per cent nitrogen.
I. 0·366 grms. gave 0·184 grms. water and 0·594 grms. carbonic acid = 5·57 per cent hydrogen and 44·26 per cent carbon.
II. 0·380 grms. gave 0·184 grms. water and 0·614 grms. carbonic acid = 5·58 per cent hydrogen and 44·01 per cent carbon.

These figures correspond to an albumen in which 6 atoms of hydrogen are replaced by 6 atoms of the nitro-group, and 1 atom of hydrogen by 1 atom of the sulphoxyl group. The generally adopted formula of albumen is

$$C_{72}H_{108}N_{18}SO_{22}.$$

(Lieberkuhn has in his formula four more atoms of hydrogen.) The formula of the new derivatives is therefore:—

$$C_{72}\left\{\begin{matrix}H_{101}\\(NO_2)_6\\SO_2OH\end{matrix}\right\}N_{18}SO_{22}$$

		Theory.	Experiment. I.	Experiment. II.
C_{72}	864	44·13	44·26	44·01
H_{102}	102	5·21	5·57	5·58
S_2	64	3·27	2·92	3·03
N_{24}	336	17·16	17·20	17·00

* Read before the Lyceum of Natural History of New York.

The rational name of this compound is, therefore, hexanitro-albumen-sulphonic acid. We know two different classes of nitro-bodies; the one class yields, by treatment with reducing agents, the original substance, as nitro-cellulose and nitro-glycerine: the other class yields amidated products, as in the case of nitro-benzoic acid. The cause of this difference in behaviour is, that in the first case the hydrogen of an hydroxyl is replaced by the nitro-group, while in the second case the hydrogen in combination with the carbon is replaced by the nitro-group. To decide to which class the hexanitro-albumen-sulphonic acid belongs, it was treated with sulphide of ammonium. After many attempts to isolate the product of reduction, I adopted the following as the best method: hexanitro-albumen-sulphonic acid is dissolved in not too great an excess of ammonia and a current of sulphuretted hydrogen gas passed through it for some time. The solution, saturated with sulphuretted hydrogen, is heated in a flask over a water-bath, till all sulphide of ammonium is volatilised (I cannot recommend evaporating in a porcelain dish, because the free access of air would effect an oxidation of the newly-formed product). The fluid is then filtered from the deposit of sulphur, and to the filtrate acetic acid is added till the formation of a precipitate ceases; this precipitate is then well washed with water and alcohol, and carefully dried.

Analysis of this precipitate resulted as follows:—

0·743 grms. gave 0·211 barium sulphate = 3·92 per cent sulphur.

0·248 grms. gave 44·13 c.c. nitrogen, at 14° C. and 742 m.m. barometer = 19·02 per cent nitrogen.

0·331 grms. gave 0·584 grms. carbonic acid and 0·203 grms. water = 48·12 per cent carbon, and 6·87 per cent hydrogen.

We have, therefore, all the (NO_2) here replaced by (NH_2), thus forming the corresponding hexamido-albumen-sulphonic acid—

$$C_{72}\left\{\begin{matrix}H_{101}\\(NH_2)_6\\SO_2OH\end{matrix}\right\}N_{18}SO_{22}$$

	Theory.		Experiment.
C	48·593	....	48·12
H	6·412	....	6·87
N	18·897	....	19·02
S	3·599	....	3·92
O	22.497	....	—

This compound is a yellowish-brown powder, almost tasteless, insoluble in dilute acids, soluble in concentrated hydrochloric acid; alkalies dissolve it readily, but on the application of heat a decomposition takes place, with development of ammonia. Nitric acid attacks it with energy and dissolves it, with disengagement of nitrous fumes. I made many attempts to obtain crystalline combinations of this substance, but in vain.

Another Derivative of Albumen with Concentrated Sulphuric Acid.—It is well known that albumen swells up considerably in concentrated sulphuric acid, but no investigation has been made as to what this product really is. I mixed in a mortar 1 part of albumen gradually with 10-15 parts of concentrated sulphuric acid, and allowed it to stand in the cold for one day; the mass was then treated with cold water till the free SO_4H_2 was all removed; the flocculent mass was placed in a dilute potassa solution (1 to 6—8), stirred sometimes, allowed to stand in the cold for one day, filtered, precipitated by acetic acid, the precipitate washed and dried. Analysis showed that it is albumen-sulphonic acid. It contains twice as much sulphur as the albumen itself, is insoluble in water, alcohol, and dilute acids, but soluble in alkalies, wherein it swells up considerably before the real solution slowly takes place. On boiling these solutions, decomposition takes place. I shall make further investigations on this subject.

ON THE ELECTROMOTIVE POWER OF METALLIC SULPHIDES.*

By WILLIAM SKEY,
Analyst to Geological Survey of New Zealand.

IN this paper the author shows by a series of experiments that several of those sulphides which are conductors of electricity have the capacity of generating strong electric currents in those solutions frequently having contact with them in a natural way.

These currents when generated from a single pair, even of dissimilar sulphides, have an intensity so great that when allowed to pass into certain metallic solutions these solutions are decomposed, the metal being deposited in a coherent form.

This was demonstrated before the Society in the following manner:—

A mass of iron pyrites and another of galena were partially immersed in a vessel charged with sea water. To each of these minerals copper wires were attached at a distance of about 3 inches from the water-line, the intervening surface of the minerals being kept dry. That wire connected with the iron pyrites was placed in a solution of sulphate of copper contained in a separate vessel—the other wire was fastened to a thin piece of platinum foil—which foil was also set in the metallic solution facing the copper wire.

In a short time, the platinum foil was shown to be electrotyped with a regular film of copper wherever it had contact with the liquid, clearly showing that voltaic action had been developed by these sulphides, the galena forming the positive element of the pair.

A series of such pairs the author thought would properly be named a sulphide battery in accordance with the custom hitherto obtaining by which new forms of batteries are designated after some distinguishing or novel feature in them.

Gold was found to be reduced from its chloride by several of the metallic sulphides; both the electrodes in these cases were of platinum. Certain silver and platinum solutions were also effected in this manner.

Other sulphides manifest the same phenomena when paired among themselves.

The annexed column represents those which have been tested to this date, the arrangement of which is from positive to negative; the exciting solution is sea water.

Any two of these connected as described will be found positive and negative repectively; that occupying relatively the highest position in the column being always the positive one.

Protosulphide of iron.
Protosulphide of manganese (manganese blende).
Protosulphide of zinc (as zinc blende).
Bisulphide of tin.
Protosulphide of mercury.
Protosulphide of silver, chemically prepared.
Protosulphide of lead (as galena).
Subsulphide of copper (as copper glance).
Ferrosulphide of copper (as copper pyrites).
Bisulphide of iron (as cubical pyrites).
Sulphide of antimony (as stibnite).
Sulphide of gold.
Sulphide of platinum.
Sulpho-arsenide of iron (as mispickel).
Carbon (graphite) sulphurised.

In connection with this table it was found that in the same solution zinc was positive to protosulphide of iron, while silver places itself between the sulphides of silver and lead; platinum between sulphide of platinum and mispickel; and, finally, carbon places itself below sulphurised carbon, to which it is, therefore, negative.

* Abstract of a Paper read before the Wellington Philosophical Society, January 29th, 1871.

The author on commenting upon what this table discloses, alludes to the singular circumstance that galena should prove to be more easily affected by such saline solutions than copper pyrites, as under ordinary circumstances it appears unalterable, copper pyrites, on the other hand, very soon discolouring.

As to the intensity of the electric current which some of these sulphides are capable of generating, the author thinks it little, if anything, inferior to that produced by zinc in similar solutions, and while its development is slower, he assumes the absolute quantity generated by the complete oxidation of iron pyrites would be about four times that yielded by the oxidation of this metal.

These results lead the author to believe that much of our native silver and gold has been electro-deposited from saline solutions by voltaic action set up by the contact of dissimilar sulphides, or of sulphides with more negative substances, such as hæmatite, magnetite, or ferruginous rocks.

They further lead him to think that those traces of electric currents discovered about forty years ago by Mr. Fox to occur in mineral lodes generally are produced by the oxidation of these sulphides, and so do not appear to be either the results of magnetic induction or of changes or differences in the temperature of adjoining rock masses, to either of which these currents have hitherto been generally attributed.

The author concludes his paper by offering the suggestion that "possibly a table like the one here constructed, when amended and enlarged by the results of further and more extensive researches upon pure, mixed, and native sulphides in this direction, may be useful to chemical geology in its attempts to trace back the history of our metalliferous deposits, since it shows (by the use of a thoroughly reliable and simple process) the relative tendency of various sulphides to decompose in those kinds of solutions most likely to have contact with them in the situations where they naturally occur."

ON THE REVIVED THEORY OF PHLOGISTON.*

By WILLIAM ODLING, M.B., F.R.S.
Fullerian Professor of Chemistry, Royal Institution.

(Concluded from page 245.)

VERY different is the view of phlogiston to be gathered from the writings of Dr. Watson, for example, who was appointed Professor of Chemistry at Cambridge in 1764, became Regius Professor of Divinity in 1771, and Bishop of Llandaff in 1782. This cultivated divine, indifferent, it is true, to the novel questions by which in less placid regions men's minds were so deeply stirred, amused the leisure of his dignified University life by writing scholarly accounts of the chemistry it had formerly been his province to teach; and in the first volume of his well-known "Chemical Essays," published in 1781, the following excellent account of phlogiston is to be found:—

"Notwithstanding all that perhaps can be said upon this subject, I am sensible the reader will still be ready to ask, *What is phlogiston?* You do not surely expect that chemistry should be able to present you with a handful of phlogiston, separated from an inflammable body; you may just as reasonably demand a handful of magnetism, gravity, or electricity to be extracted from a magnetic, weighty, or electric body. There are powers in nature which cannot otherwise become the objects of sense, than by the effects they produce; and of this kind is phlogiston. But the following experiments will tend to render this perplexed subject somewhat more clear.

"If you take a piece of *sulphur* and set it on fire, it will burn entirely away, without leaving any ashes or yielding any soot. During the burning of the sulphur, a copious vapour, powerfully affecting the organs of sight and smell, is dispersed. Means have been invented for collecting this vapour, and it is found to be a very strong acid. The acid thus procured from the burning of sulphur, is incapable of being either burned by itself, or of contributing towards the support of fire in other bodies; the sulphur from which it was procured was capable of both: there is a remarkable difference, then, between the acid procured from the sulphur and the sulphur itself. The acid cannot be the only constituent part of sulphur; it is evident that *something* else must have entered into its composition, by which it was rendered capable of combustion. This something is, from its most remarkable property, that of rendering a body combustible, properly enough denominated the food of fire, the *inflammable principle*, *the phlogiston*. . . . . This inflammable principle, or phlogiston, is not one thing in animals, another in vegetables, another in minerals; it is absolutely the same in them all. . . . . This identity of phlogiston may be proved from a variety of decisive experiments; I will select a few, which may at the same time confirm what has been advanced concerning the constituent parts of sulphur.

"From the analysis or decomposition of sulphur effected by burning, we have concluded that the constituent parts of sulphur are two—an *acid* which may be collected, and an *inflammable principle* which is dispersed. If the reader has yet acquired any real taste for chemical truths, he will wish to see this analysis confirmed by synthesis; that is, in common language, he will wish to see sulphur actually made by combining its acid with an inflammable principle. It seldom happens that chemists can reproduce the original bodies, though they combine together all the principles into which they have analysed them. . . . In the instance, however, before us, the reproduction of the original substance will be found complete.

"As the inflammable principle cannot be obtained in a palpable form separate from all other bodies, the only method by which we can attempt to unite it with the acid of sulphur must be by presenting to that acid some substance in which it is contained. Charcoal is such a substance; and by distilling powdered charcoal and the acid of sulphur together, we can produce a true yellow sulphur, in nowise to be distinguished from common sulphur. This sulphur is formed from the union of the acid with the phlogiston of the charcoal; and the charcoal may by this means be so entirely robbed of its phlogiston, that it will be reduced to ashes, as if it had been burned. . . . .

"I will in this place, by way of further illustration of the term phlogiston, add a word or two concerning the necessity of its union with a metallic earth, in order to constitute a metal. Lead, it has been observed, when melted in a strong fire, burns away like rotten wood; all its properties as a metal are destroyed, and it is reduced to ashes. If you expose the ashes of lead to a strong fire, they will melt; but the melted substance will not be a *metal*, it will be a yellow or orange-coloured *glass*. If you pound the glass, and mix it with charcoal dust, or if you mix the ashes of the lead with charcoal dust, and expose either mixture to a melting heat, you will obtain, not a *glass*, but a metal, in weight, colour, consistency, and every other property the same as lead. The ashes of lead melted *without* charcoal become *glass*; the ashes of lead melted *with* charcoal become a *metal*. The charcoal, then, must have communicated *something* to the ashes of lead, by which they are changed from a glass to a metal. Charcoal consists of but two things—of ashes and of phlogiston; the ashes of charcoal, though united with the ashes of lead, would only produce glass; it must, therefore, be the other constituent part of charcoal, or phlogiston, which is communicated to the ashes of lead, and by an union with which the ashes are restored to their metallic form. The ashes of lead can never be restored to their metallic form without their being united with

* A Lecture delivered at the Royal Institution of Great Britain, April 28th, 1871.

some matter containing phlogiston, and they may be reduced to their metallic form by being united with *any* substance containing phlogiston in a proper state, whether that substance be derived from the animal, vegetable, or mineral kingdom; and thence we conclude not only that phlogiston is a necessary part of a metal, but that phlogiston has an identity belonging to it, from whatever substance in nature it be extracted. And this assertion still becomes more general, if we may believe that metallic ashes have been reduced to their metallic form, both by the solar rays and the electrical fire."

The foregoing account by Dr. Watson is almost a translation from Stahl's "Zymotechnica Fundamentalis, simulque experimentum novum sulphur verum arte producendi," in which he establishes what may be called the permanency of chemical substance—that metallic lead is reproducible from the ashes of lead, *sulphur verum* from the acid of sulphur. And, whether or not taking note of the oxidations and deoxidations effected, how little differently, even at the present day, would the actions referred to be described and explained. Is it not our habit to say that charcoal and sulphur and lead are bodies possessing potential chemical energy—that is, phlogiston; that in the act of burning, their energy which was potential becomes kinetic or dynamical, and is dissipated in the form of light and heat; that the products of their burning (including the gaseous product now known to be furnished by the burning of charcoal) are substances devoid of chemical energy, that is of phlogiston; that when the acid substance furnished by burning sulphur is heated with charcoal, some energy of the unburnt charcoal is transferred to the burnt sulphur, just as some energy of a raised weight may be transferred to a fallen one, whereby the burnt sulphur is unburnt, provided with energy, and enabled to burn again, and the fallen weight is lifted up, provided with energy, and enabled to fall again; that the potential chemical energy of metallic lead did not originate in the lead, but is energy or phlogiston transferred thereto from the charcoal by which it was smelted; and lastly, that the chemical energy of the charcoal itself, its capability of burning, its power of doing work, in one word its phlogiston, is merely a portion of energy appropriated directly from the solar rays.

If this be a correct interpretation of the phlogistic doctrine, it is evident that the Stahlians, though ignorant of much that has since become known, were nevertheless cognisant of much that became afterwards forgotten. For most of what has since become known, mankind are indebted to the surpassing genius of Lavoisier; but the truth which he established, alike with that which he subverted, is now recognisable as a partial truth only; and the merit of his generalisation is now perceived to consist in its addition to—its demerit to consist in its supersession of—the not less grand generalisation established by his scarcely remembered predecessors. This being so, the relationship to one another of the Stahlian and Lavoisierian theories of combustion furnishes an apt illustration of the general truth set forth by a great modern writer, that "in the human mind, one-sidedness has always been the rule, and many-sidedness the exception. Hence, even in revolutions of opinion, one part of the truth usually sets while another rises. Even progress, which ought to superadd, for the most part only substitutes one partial and incomplete truth for another; improvement consisting chiefly in this, that the new fragment of truth is more wanted, more adapted to the needs of the time, than that which it displaces."

The partial truth contributed by Lavoisier was indeed more wanted, more adapted to the needs of the time, than the partial truth which it displaced. To him chemists are indebted for their present conception of material *elements*; and especially for their knowledge of the part played by the air in the phenomena of combustion, whereby oxygenated *compounds* are produced. The phlogistians, indeed, were not unaware of the necessity of air to combustion, but being ignorant of the nature of air were necessarily ignorant of the function which it fulfilled. To burn and to thrown off phlogiston being with them synonymous expressions, the air was conceived to act by somehow or other enabling the combustible to throw its phlogiston off; and a current of air was conceived to promote combustion by enabling the combustible to throw its phlogiston off more easily. Moreover, contact of air was not essential to combustion, provided there was present instead some substance, such as nitre, which equally with, or even more effectively than air, could enable the combustible to discharge itself of phlogiston. But while the phlogistians, on the one hand, were unaware that the burnt product differed from the original combustible otherwise than as ice differs from water, by loss of energy, Lavoisier, on the other hand, disregarded the notion of energy, and showed that the burnt product included not only the stuff of the combustible, but also the stuff of the oxygen it had absorbed in the burning. But, as well observed by Dr. Crum-Brown, we now know "that no compound contains the substances from which it was produced, but that it contains them *minus* something. We now know what this something is, and can give it the more appropriate name of potential energy; but there can be no doubt that this is what the chemists of the seventeenth century meant when they spoke of phlogiston."

Accordingly, the phlogistic and antiphlogistic views are in reality complementary and not, as suggested by their names and usually maintained, antagonistic to one another. It has been said, for example, that according to Stahl, the product of combustion is simple, and the combustible a compound of the product with imaginary phlogiston—which is false; whereas, according to Lavoisier, the combustible is simple, and the product a compound of the combustible with actual oxygen—which is true. But in this case, as in so many others, everything turns upon the use of the same word in a different sense at different periods of time. When Lavoisier spoke of red lead as being metallic lead combined with oxygen, he meant that the matter or stuff of the red lead consisted of the matter or stuff of lead *plus* the matter or stuff of oxygen. But when the Stahlians spoke of metallic lead being burnt lead combined with phlogiston, they had the same sort of idea of combination in this instance, as others have expressed by saying that the weight of a body is compounded of its matter and its gravity; or that steam is a compound of water and heat; or, to use a yet more Lavoisierian expression, that oxygen gas itself is a compound of the basis of oxygen with caloric. It is not, then, that the one statement, Stahlian or Lavoisierian, is false and the other true, but that both of them are distorted, because incomplete. Chemists nowadays are both Stahlian and Lavoisierian in their notions; or have regard both to energy and matter. But Lavoisierian ideas still interfere very little with our use of the Stahlian language. While we acknowledge that in the act of burning the combustible and the oxygen take equal part, just as in the act of falling the weight and the earth take equal part, yet in our common language we alike disregard the abundant atmosphere and abundant earth as being necessarily understood, and speak only of the energy of the combustible and of the weight, which burn and fall respectively. Whatever may be the fault of language, however, chemists do not omit to superpose the Lavoisierian on the Stahlian notion. They recognise fully that it is by the union of the combustible with oxygen that phlogiston is dissipated in the form of heat; and further, that phlogiston can only be restored to the burnt combustible on condition of separating the combustible from the oxygen with which it has united; just as energy of position can only be restored to a fallen weight on condition of separating it to a distance from the surface on which it has fallen.

That Stahl and his followers regarded phlogiston as a material substance, if they did so regard it, should interfere no more with our recognition of the merit due to their doctrine than the circumstance of Black and Lavoisier regarding caloric as a material substance, if they did so

regard it, should interfere with our recognition of the merit due to the doctrine of latent heat. But though defining phlogiston as the principle or matter of fire, it is not at all clear that the phlogistians considered this matter of fire as constituting a real body or ponderable substance; but rather that they thought and spoke of it as many philosophers nowadays think and speak of the electric fluid and luminiferous ether. The nondescript character, properly ascribable to phlogiston, is indicated by the following quotation taken from Macquer's "Elemens de Chymie Theorique," 1749. It must not, of course, be forgotten that the popular impression as to phlogiston having been conceived by its advocates as a material substance having a negative weight or levity, is erroneous; and is based on an innovation that was introduced during the struggling decadence of the phlogistic theory, and advocated more particularly by Lavoisier's subsequent colleague, Guyton de Morveau, in his "Dissertation sur le Phlogistique, considéré comme Corps grave, et par rapport aux changemens de pesanteur qu'il produit dans les corps auxquels il est uni," 1762. Macquer writes as follows:—

"La matière du soleil, ou de la lumière, le phlogistique, le feu, le soufre principe, la matiére inflammable, sont tous les noms par lesquels on a coutume de désigner l'élément du Feu. Mais il paroît qu'on n'a pas fait une distinction asséz exacte . . . . du nom qu'il mérite véritablement lorsqu'il entre effectivement comme principe dans la composition d'un corps, ou bien lorsqu'il est seul et dans son état naturel. Si on l'envisage sous cette dernière vue, le nom de Feu, de matière du soleil, de la lumière et de la chaleur, lui convient particulièrement. Pour lors, c'est une substance que l'on peut considérer comme composée de particules infiniment petites, qui sont agitées par un mouvement très rapide et continuel, par conséquent essentiellement fluide. Cette substance, dont le soleil est comme le réservoir général, s'en émane perpetuellement, et est répandue universellement dans tous les corps que nous connoissons; mais non pas comme principe ou essentielle à leur mixtion, puisqu'on peut les en priver, du moins en grande partie, sans qu'ils souffrent pour cele la moindre décomposition. . . . . Cependant les phénomènes que présentent les matières inflammables lorsqu'elles brulent, nous indiquent qu'elles contiennent réellement la matière du Feu comme un de leurs principes. . . . . Examinons donc les propriétés de ce feu fixé, et devenu principe des corps. C'est lui auquel nous donnerons particulièrement le nom de matière inflammable, due soufre principe, ou de phlogistique, pour le distinguer du Feu pur."

Again, much the same thing is to be found in Baumé's "Manuel de Chymie," 1765; as for example:—

"Nous considérons le feu sous deux états différens. Lorsqu'il est pur, isolé, et qu'il ne fait partie d'aucun composé . . . . Lorsqu'il est combiné avec d'autres substances, et qu'il fait un des principes constituans des corps composés . . : . On n'est pas certain si le feu est pesant. Il y a des expériences pour et contre. . . .

"Pendant la combustion des substances, le feu combiné se reduit en feu élémentaire, et se dissipe à mesure. Le célébre Boerhaave n'est cependant pas de ce sentiment; il dit que si cela étoit, la quantitè de feu élémentaire devroit augmenter à l'infini dans la nature. . . . . Mais il est facile de répondre à cette objection, en disant comme on est on droit de la présumer, que le feu élémentaire, dégagé des corps, se combine à mesure avec d'autres substances, et qu'il perd toutes ses propriétés de feu libre, en devenant principe constituent des corps, dans la composition desquels il entre. . . . . Le principe dont nous entendons parler ici, est celui que Stahl a nommé *phlogistique*."

In interpreting the above and other phlogistic writings by the light of modern doctrine, it is not meant to attribute to their several authors the precise notion of energy that now prevails. It is contended only that the phlogistians had, in their time, possession of a real truth in nature which, altogether lost sight of in the intermediate period, has since crystallised out in a definite form. "I trust," said Beccher, "that I have got hold of my pitcher by the right handle." And what he and his followers got hold of and retained so tenaciously, though it may be shiftingly and ignorantly, we now hold to knowingly, definitely, and quantitatively, as part and parcel of the grandest generalisation in science that has ever yet been established.

ON THE

EFFECT OF CERTAIN METALLIC SUBSTANCES BESIDES IRON ON CARBONIC OXIDE, INCLUDING SILICON.*

By I. LOWTHIAN BELL.

A DENSE fume is emitted from furnaces smelting the Cleveland ironstone, and this, condensing, lodges in large quantities in the pipes for conducting the gases to the boilers, &c. In the so-called flue-dust zinc is always found, and in most ores there is more or less manganese, occasionally copper, often titanium, and some other metals.

Under the circumstances, it was natural to try the power of metals thus often found associated with iron in its ores, in splitting up CO, to which was added experiments upon others not generally found in connection with that one which it is our more immediate province to examine.

In the following experiments every care was taken to have the CO free from cyanogen, otherwise a carbonaceous deposit, probably paracyanogen, takes place, and to have the metals and their oxides without a trace of iron. In one case, that of copper, in the first trials a minute quantity of carbon was found deposited, which subsequent investigation proved to be caused by a trace of iron being present.

Manganese.—

Dioxide (MnO_2) was obtained by boiling an alkaline permanganate with nitric acid, and drying the precipitate after it was thoroughly washed.

Manganoso-manganic oxide (Mn_3O_4) was got by heating pure $MnCO_3$ in a current of air until it contained no trace of CO_2. The $MnCO_3$ was procured free from iron by adding a small quantity of Na_2CO_3 to a solution of manganese, and boiling the resulting turbid liquor until every trace of iron was precipitated by the $MnCO_3$ thrown down at first. The filtered liquid thus freed from Fe was then precipitated by further addition of Na_2CO_3, and the precipitate thoroughly washed and dried.

These two oxides were exposed to a stream of pure CO with the results given below:—

	Expt. 376.	*Expt.* 377.	*Expt.* 378.
	MnO_2.	MnO_2.	Mn_3O_4.
Time of exposure ..	4½ hours	6½ hours	10 hours
Temperature—	Below red heat.	Zinc softened.	Zn fused, Sb not.
Loss of weight.. ..	—	19·6 per ct.	7·1 per ct.
Theoretical loss for reduction to MnO	—	18·4 „	7·0 „
Increase of weight on roasting in oxygen	7·53 per ct.	—	—
Theoretical increase of weight for Mn_3O_4	7·51 „	—	—
Carbon deposited ..	*nil*	*nil*	*nil*

From these trials it seems that MnO_2, at a heat short of redness, is converted by CO into MnO in 4½ hours, and that both MnO_2 and Mn_3O_4 lose oxygen readily at the temperature of melting zinc, both being reduced to MnO.

* From the "Chemical Phenomena of Iron Smelting."

In no case was there a trace of carbon present. It would therefore appear that oxides of Mn are incapable of acting on CO, as Fe does, by separating this gas into C and CO_2, and that no suboxide Mn_2O is formed.

Copper.—

Pure copper oxide was got by electrolysis of re-crystallised sulphate, solution in nitric acid, evaporation, and ignition.

Expt. 379.—The oxide of copper was exposed at a temperature of melting zinc to CO for 7 hours, after which its composition was—

Copper	98·1
Oxygen	1·9
C	*nil*
	100

So that reduction was nearly complete in this time.

Expt. 380.—At a low red heat, oxalic acid gas (equal vols. CO and CO_2) withdrew all the oxygen from oxide of copper. The loss of weight was 20·3 per cent—20·2 per cent being the theoretical equivalent of O. No carbon was precipitated.

Expt. 381.—Pure spongy Cu, obtained by reducing the above oxide in H, was kept in contact with CO for 10 hours, at a temperature of melting zinc. No change of weight, hence no C deposited.

Expt. 382.—Pure spongy Cu, exposed for 2 hours to oxalic acid gas, at a dull red heat, did not alter in weight.

Zinc.—

ZnO was obtained by treating pure $ZnCl_2$ with Na_2CO_3, and igniting the $ZnCO_3$ obtained—

Expt. 383.—Exposed at temperature of melting zinc to pure CO for 6½ hours. No carbon deposited, nor was there any sensible amount of reduction, the weight of the product not being altered by moistening with NO_3H, and gentle ignition.

Tin.—

Stannic oxide obtained by oxidation of block tin by nitric acid.

Expt. 384.—Action same as with ZnO in CO, at temperature of melting zinc. No carbon, nor any appreciable amount of reduction, the weight not altering sensibly by treatment with NO_3H.

Chromium.—

Expt. 385.—Anhydrous chromic oxide obtained by igniting potassium anhydro-chromate (bichromate of potash), and washing the product. Had become darker, but contained no carbon, and was in other respects unchanged by exposure to CO for 7½ hours, in lead bath, to about 410° C. (770° F.).

Expt. 386.—Hydrated chromic oxide, got by precipitation of chloride by means of ammonia, was exposed at the same time as the chromic oxide in previous experiment. Original colour bluish-green, changed to bright green. In other respects no change, save that almost the whole of the water of hydration was expelled.

Lead.—

Lead oxide got by ignition of crystallised nitrate:—

Expt. 387.—PbO exposed to CO, for 6½ hours, at a temperature of melting zinc. Perfect reduction ensued.

Expt. 388.—PbO, same treatment and same results, at red heat, in 6½ hours. No trace of carbon in either of these experiments.

Nickel.

Re-crystallised nickel nitrate (commercially pure) was boiled with nitric acid, and an excess of ammonia added. This dissolved the precipitated oxide of nickel, but left a trace of Fe_2O_3, which was separated in the usual way. The alkaline solution of the oxide of nickel was evaporated to dryness, and ignited in two portions. Either from the presence of a little adhering nitrate of ammonia, or from differences in the temperature at which ignition was effected, two different oxides were obtained—the one, compact, and nearly corresponding to NiO (Ni 78·7 O 21·3); and the other to Ni_2O_3 (Ni 71·1 O 28·9).

The two oxides of nickel thus obtained had the following composition, arrived at by reducing known weights of each in pure hydrogen.

	Compact Oxide.	Black Oxide.
Ni	77·5	71·2
O	22·5	28·8
	100	100

These two substances were exposed to a current of pure CO in the lead bath arrangement:—

Expt. 389.—Compact oxide. *Expt.* 390.—Black oxide.

		Time of exposure, 7½ hours. Temperature—Zinc melted, Antimony not affected.	Time of exposure, 10 hours. Temperature—Zinc melted, Sb not.
Composition of product.	Ni ..	87·2	28·1
	O ..	12·2	—
	C ..	0·6	71·9
		100·0	100·0

In experiment 389 the residual oxygen is just 14·0 per cent of the weight of the total nickel present: this represents an oxide, having almost exactly the composition of Ni_2O (which requires 13·6 to 100 Ni). No nickel, in this case, was dissolved out by iodine; and as iodine was found to attack spongy nickel reduced by hydrogen, with ease, there could have been no metallic nickel present.

It was shown formerly (Experiments 62 to 69), that in several instances where Fe_2O_3 had been imperfectly reduced by CO, the proportion between the iron insoluble in iodine and the residual oxygen was almost exactly that required to form a suboxide, Fe_2O: hence it would appear that nickel and iron are analogous in this respect also, viz., that the suboxides of both are not acted on by iodine and cold water. As will be presently shown, Co_2O, if formed, is acted on thus, the product being, however, not the sesquioxide (as in the case of iron when the hydrated protoxide is thus oxidised), but the protoxide.

In the case of the Ni_2O_3 the carbon and oxygen determinations were faulty, and the sum of both was ascertained by finding the quantity of nickel present in the mass after exposure to CO. The result is such that there must have been a carbon deposition equal to about 250 per cent of the nickel actually present.

In a stream of oxalic acid gas (equal volumes of CO and CO_2) the compact oxide gave the following results:—

		Per cent.
Expt. 391.—O lost in	2½ hours .. at a low red heat,	20·4
Do.	3 ,, more do.	1·1
Do.	3 ,, ,, do.	0·2
	8½	21·7
Expt. 392.—O lost in	3 hours .. at a bright red heat,	22·0
Do.	2 ,, more do.	0·1
	5	22·1

The original oxygen present being 22·5 per cent, it appears that a mixture of equivalents of CO and CO_2 has the power, at both these temperatures, almost completely to deoxidise NiO.

Trials were then made to discover the action of the pure spongy metal on pure CO. A portion of the compact oxide was reduced in hydrogen until no more H_2O was evolved. A current of CO was then passed over the metallic Ni thus obtained:—

Expt. 393.—Time of exposure, 5 hours. *Expt.* 394.—5 hours.

		Temperature—Melting zinc.	Bright red heat
Composition of product.	Ni ..	99·93	100·0
	C ..	0·04	—
	O ..	0·03	—
		100·0	100·0

The dissociation, therefore, of the CO at a temperature of melting zinc was very feeble, and at a bright red heat it was *nil*.

The power of the spongy metal to decompose CO_2 was next made the subject of investigation.

Expt. 395.—At melting zinc no appreciable amount of CO was obtained after 30 minutes' exposure, the metal gaining in weight 0·3 per cent, probably due to traces of moisture and air present.

Expt. 396.—At a low red heat the metal gained 3 per cent of its weight in 90 minutes.

Expt. 397.—At a bright red heat 40 c.c. of gas were obtained after 40 minutes' exposure, which was unabsorbed by potash. It was found to contain 96 per cent of CO.

Expt. 398.—Spongy nickel, at a moderately bright red heat, was unaffected after an exposure of 15 hours to oxalic acid gas (equal vols. of CO and CO_2).

The nickel oxide employed in these experiments might contain some cobalt, but, if so, it was the minutest trace; not the faintest indication of its presence being shown by the very delicate test afforded by the borax bead before the blowpipe.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

ROYAL IRISH ACADEMY.

May 29th, 1871.

AT the general meeting of the Academy, the President, the Rev. J. JELLETT, read a paper upon "*The Cultivation of Beet-Root Sugar in Ireland.*"

Six specimens of the white beet, grown at the Model Farm at Glasnevin, had been examined with the Jellett saccharometer. The sliced root was digested with weak alcohol three or four times; the solutions were evaporated and then made up, after having been heated to 180°, to a given bulk with water. This solution was filtered through charcoal, and the first portions rejected as a certain amount of the sugar is absorbed. The sugar present in the beet almost entirely consisted of cane sugar. The following are the results of the six determinations:—

1st.	12·05	per cent
2nd.	9·50	,, ,,
3rd.	12·58	,, ,,
4th.	12·59	,, ,,
5th.	11·62	,, ,,
6th.	12·43	,, ,,

Professor Jellett said that anything over 10 per cent might be considered very good and would pay to work.

Dr. SULLIVAN remarked (in a discussion that followed) that he was very glad to find his statements corroborated, viz., that beet-root could be easily grown in Ireland containing 10 to 12 per cent of sugar. No 2, which contained only about 9 per cent of sugar, had not been earthed up, and this fact is corroborative of a statement that a powerful sun was not necessary to produce saccharine matter in the root. All the other specimens had been earthed up.

Dr. W. SULLIVAN then read a paper "*On the Comparative Chemical Composition of Ancient Bronzes*," which was in connection with the ethnology, metallurgy, and commerce of the ancient people of Europe.

CORRESPONDENCE.

TECHNICAL EDUCATION FOR THE SONS OF FARMERS.

To the Editor of the Chemical News.

SIR,—By the enclosed extract you will see that I have been anxious to set on foot a scheme cognate to that of Mr. Little, whose plan I was most glad to read in your last number. I should be glad to work with him, and propose a central committee. By inserting my enclosed letter you will oblige me, and, I think, forward the cause. —I am, &c.,

MARSHALL HALL.

New University Club, May 27, 1871.

"To the Editor of the 'Devizes Gazette.'

"SIR,—In these days of Educational talk and of School Boards, there is no need of apology for addressing you upon a branch of the subject which receives too little attention, more especially in agricultural districts. Education must begin from above, and work downward. From the squire to the farmer, from the farmer to the labourer; and, again, from the manufacturer to the artizan must be its course. I certainly think that at this present day we are all awakening to the necessity of educating every man according to his trade, and also to the fact that every man has his trade; that the squire's duties should lead him to the study of political economy, of the law, of the natural sciences, and especially those connected with agricultural operations and accounts. The farmer, when without such things as agricultural chemistry and the physiology of plants, is in mediæval darkness; and the labourer, without the discipline of reading, writing, and arithmetic, is without the proper chances either of justly estimating his present position or of availing himself of the chances which may occur of bettering it. As I have said, the upper classes are quickly awakening to the requirements of a rational training for their sons. The next class also; witness the existence of the Royal Agricultural College: but it is for them to pass on the movement, as it were, to those beneath them. But an especially large class, that of farmers of medium and small holdings, can scarcely afford the means to send their lads to College, nor indeed can they always spare the time and labour which would be taken from home. It follows, therefore, that, if possible, a plan should be proposed for bringing at all events an elementary means of instruction in the higher branches of their own occupation within their reach, at such a cost of time and money as need deter none from taking advantage of it. And, premising that there shall exist a good foundation in reading, writing, and arithmetic, I think I can point out how to obtain this object. At the local centres which form the chief markets of the county, such as Salisbury, Devizes, Chippenham, Trowbridge, or such of these and other places as may be shown to be advisable, not merely from their population but from the number of farms around them, let there be established classes to be held on winter afternoons and evenings, first of every thing in bookkeeping, and then in botany, agricultural chemistry, and geology, and the first elements of surveying. There can be no reason why a class should not be held for mechanics, if sufficient in number. Such a work as Goodeve's "Elements of Mechanism" would be inestimable to the humblest artizan, and yet within his mastery. The farmer can take up no better book than "How Crops Grow," and "Church's Laboratory Guide." But none of these will be much good without the assistance of a master. And the way in which these classes might be held would be to pay, say two travelling professors, whose duties should be confined to the county, who should hold classes two evenings a week each at three places. This could be done by a very moderate subscription. It is by no means my idea to afford such classes as a species of charity. I think those who use them would ultimately be sufficient in number to pay for them. But not so at starting, and perhaps a subscription in aid may at all times be useful for proper development of my scheme. There can be no doubt that landlords subscribing will get their money back again through the class of tenants produced in a few years. Finally, these classes would always be an invaluable preparation for the College at Cirencester, and for others of the higher educational institutions. I need not

say that I hope to subscribe myself, and if ever a laboratory is established, say in Devizes, I shall hope to assist in the plain fitting out that will be requisite. I will also contribute to the educational library which will be necessary. At the approaching Quarter Sessions let me ask my brother landlords and my friends the farmers to talk these matters over. I beg those who kindly wish to assist to communicate with me, especially as to forming a private committee for consideration.—MARSHALL HALL, Brighton, Dec. 27, 1870."

MISCELLANEOUS.

Cambridge Local Examinations.—At the meeting presided over the other day by Lord Houghton, at the London University, it was shown that the percentage of those who passed this year, both of boys and girls, had decreased in every department. Of thirty-two juniors from the City of London, four took honours, thirteen passed, and fifteen failed. In that most popular of scientific subjects among the seniors, chemistry, two only passed, out of seventeen presented, one from the Proprietary School, Gravesend, taught by the Professor of Chemistry at the Birkbeck Institution, and one from Denbigh. The examiners declared that "many had come up to be examined on subjects of which they literally knew nothing!" —*City Press.*

The North Austrian Industrial Association.—We have been favoured with a paper from this Association, of which the following is a condensed summary:—It having been found that exhibitors at all the exhibitions hitherto held, and also many of the juries, expressed a well-founded dissatisfaction with the system of giving prizes, the industrial association above-mentioned has adopted the proposal of one of its members, M. F. Ritter von Wertheim, to request all who feel interested in this question to try to reply to the following query, which is put as a prize essay:—"In what manner are to be avoided, or how and by what simple and efficient means are to be improved, the methods of granting and distributing prizes hitherto pursued at exhibitions, at the Great Exhibition which is to take place at Vienna in the year 1873." For the three best essays on this subject, the North Austrian Industrial Association intends to give one of its great gold and two great silver medals, presented for this purpose by M. F. Ritter von Wertheim, upon the following conditions:—The writer or author is not to content himself with simple suggestions, but he should, even though this be done briefly, criticise and expose the advantage as well as the defects of the methods of granting and giving prizes as hitherto pursued at public, general, and other industrial exhibitions, and next propose his plan of an improved method. The essays must be sent in not later than the end of October next, and are to be provided with a motto, and with a sealed note bearing on the outside cover the same motto, and inside the author's name. The manuscripts of the essay remain the property of those to whom the medals shall be given, but the North Austrian Industrial Association (Der N. O. Gewerbe Verein), reserves to itself the right of printing and publishing the essays in its own Transactions. The manuscripts (to be sent carriage or postage paid, to the address of Herr C. V. Scherzer, President of the Association at Vienna) will not be returned, but the essays may be taken back by the authors from the office of the Association. The jury to consider the essays will be appointed by the Association; the medals will be awarded at the General Annual Meeting of the Association in December next. The names of the successful authors of the essays will be made public in all German and, as far as possible, all other European and American newspapers.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Polytechnisches Journal von Dingler, second number for April, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and collateral sciences:—

Improved Copper-Zinc Battery.—L. Kohlfürst.—The arrangement alluded to in this paper cannot be described without reference to the woodcuts added to it.

Reduction of Chloride of Silver in the Moist Way.—Dr. Grüger.—This paper contains the detailed description of the reduction of chloride of silver dissolved in ammonia by means of metallic zinc, which process, according to the author, succeeds very well, and yields a silver of greater purity than is obtained by the process for reduction of silver by the moist way now in use, provided the operation be carried on in closed wide-mouthed stoppered bottles. The silver, after complete reduction (and this has to be tested for by means of a drop of the ammoniacal fluid being put into some hydrochloric acid), is first thoroughly washed with concentrated hydrochloric acid, next with water, and, lastly, for some moments with dilute ammonia, and then again with distilled water, and provided the zinc be used in large lumps thick enough to admit of being readily removed from the spongy silver. It is clear that this method of reduction involves the use of a considerable quantity of ammonia; but this, the author states, can in great measure be recovered by distillation.

Regeneration of Waste Silver Solutions used in Photography.—Dr. Grüger.—After first referring to the generally applied and well-known means now in use for this purpose, the author states that the best plan to treat these solutions is the following:—The solutions are boiled either in a porcelain basin or glass flask, and while boiling there is added to them recently precipitated, well washed, and moist oxide of silver, the boiling being continued for some time. The liquid is next filtered, and then evaporated to dryness, the heat being increased to fusion, so as to destroy ammoniacal salts; the residue is pure nitrate of silver. The sediment on the filter contains some oxide of silver, which must be added in excess; and, therefore, in order not to lose that, the filter is preserved, and the contents worked up at a subsequent operation. The nitrate of silver thus obtained is, by practical photographers, pronounced to be of excellent quality.

Theoretical Estimation of the Value of Various Fire-Clays.—Dr. C. Bischof.—The first portion of a lengthy monograph on this subject, which, however valuable the contents, does not admit of any useful abstraction.

Quantitative Estimation of Nitric Acid.—Dr. A. Wagner.—This method is based upon the fact that when saltpetre, or any other nitrate, is ignited, access of air being excluded, with an excess of oxide of chromium and carbonate of soda, the nitric acid oxidises the chromic oxide according to the formula $Cr_2O_3 + NO_5 = 2CrO_3 + NO_3$. 76·4 parts, by weight, of oxide of chromium are oxidised to chromic acid by 54 parts of nitric acid, or of 1 of chromic oxide by 0·7068 of nitric acid. The operation is performed by taking from 0·3 to 0·4 grm. of the nitrate, mixing it intimately with 3 grms. of chromic oxide and 1 grm. of carbonate of soda, introducing this mixture into a hard German glass combustion-tube, one end of which is drawn out, and a vulcanised india-rubber tube attached to it, which is made to dip for about a quarter of an inch into water, while to the other open end, by means of a cork and glass tube bent at right angles, an apparatus is fitted for the evolution of carbonic acid gas, which is made to pass through the tube before igniting it, and kept passing through all the time until the tube is quite cool again after ignition. The contents of the tube are placed in warm water, and after filtration the chromic acid is estimated by Rose's method. This process of estimating nitric acid, having been tested by the author with various nitrates, has been found to yield very accurate results.

Industrial Manufacture of Treacle and Dry Sugar from Starch.—C. Krötke.—A lengthy practical treatise on this subject.

Annalen der Chemie und Pharmacie (Supplementband viii.), No. 1, 1871.

This number contains the following original papers and memoirs:—

Occurrence of the Ammoniacal-Magnesian Sulphate in the Lagoons of Tuscany.—Dr. O. Popp.—This essay contains the account of a series of investigations made by the author on the constituents of the boric acid-producing lagoons of Tuscany. The salt alluded to above does not occur to the same quantity in the water of all these lagoons, since that of those producing boric acid in the purest and largest quantity is either not at all, or only slightly, impregnated with the ammoniacal-magnesian sulphate, which is found in a pure state

in the lagoons of Sasso and Aqua Viva. The re-crystallised salt was found to consist, in 100 parts, of—NH_3, 9·355; MgO, 11·043; $2SO_3$, 44·410; 7HO, 35·127;—total, 99·935. Formula—

$$NH_4O,SO_3+MgO,SO_3+6HO.$$

Formation of Boracic Acid in the Fumaroles of Tuscany.—Dr. O. Popp.—This memoir records, in the first place, the various theories and hypotheses which have been hitherto published for the purpose of explaining the presence, origin, and formation of boracic acid in the active volcanic formation of Tuscany; while, secondly, the author brings forward some experiments tending to explain the formation of boracic acid by the decomposition of boracic minerals under the influence of various reactions which may be supposed to take place aided by the high temperature of the locality, as called forth by volcanic action.

Cumaric Acid, Hydrocumarine, and Hydrocumaric Acid.—M. C. Zwenger.—After describing at length the preparation of cumaric acid from cumarine by the action of a very concentrated solution of caustic potassa, the author states that the purified acid is difficultly soluble in cold, somewhat more readily in boiling, water, from which it is deposited in anhydrous needle-shaped crystals. The acid is more readily soluble in alcohol and ether; the solutions exhibit a strongly acid reaction to test-paper, and decompose alkaline and other carbonates. Cumaric acid fuses at 195°; by dry distillation it yields chiefly phenol; on being fused with caustic potassa, hydrogen is given off and salicylate and acetate of potassa formed. The formula of this acid is $C_9H_8O_3$. Next follows a detailed description of the salts of this acid, and a discussion on the cumarine contained in the *Trifolium repens*, and in the so-called *fahauitea*; it appears that in these vegetables cumaric acid is also present. Hydrocumaric acid is obtained, along with other substances, by treating an aqueous solution of excess of cumarine with sodium amalgam. The new acid is a crystalline body, scarcely soluble in water, but more readily so in alcohol and ether; formula, $C_{18}H_{18}O_6$. By the elimination of two molecules of water, hydrocumaric acid is converted into hydrocumarine, $C_{18}H_{16}O_4$, a solid crystalline body, almost insoluble in water, alcohol, and ether, and fusing at 222°.

Molecular Weight of some Protoxides.—Dr. A. Ladenburg.—This monograph contains the following sections:—General review; protoxides of iron, manganese, and chromium; tin compounds.

Schiel's Chloral-Uric Acid.—Dr. N. Lubavin.—The main result of this paper is to prove that the acid alluded to, described by M. Schiel (*Ann. Chem. Pharm.*, vol. cxii., p. 78, 1859), and obtained by that author by the action of an aqueous solution of chlorous acid upon uric acid, is not a chemical compound at all, but a mixture of parabanic acid with chloride of ammonium; while the author of this paper also found that, by the action of chlorous acid upon uric acid, intermediate, but unstable, oxidation compounds were formed.

Derivatives from Anethol.—Dr. A. Ladenburg.—After referring at length to his former researches, and also those of other chemists on this subject, the author describes the mode of preparation of anol from anethol by the action of fused caustic potassa. The new compound (anol) $C_8H_{10}O$, is soluble in alcohol, ether, chloroform, and boiling water; the substance is very prone to decomposition, and, owing to the small quantity obtained, no derivatives of this body were prepared. The lengthy essay further treats on the action of PCl_5 and bromine upon anethol.

Researches on Vanadium.—Dr. H. E. Roscoe.—The third part of this lengthy monograph, divided into the following sections:—Bromides of vanadium; vanadium and iodine; salts of vanadic acid; artificially-made vanadinite.

Second Axiom of the Mechanical Theory of Heat, and its Application to some Phenomena of Decomposition.—Dr. A. Horstmann.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 7, 1871.

This number contains the following original papers and memoirs:—

Bromal and the By-Products obtained in its Preparation.—Dr. L. Schäffer.—The author, while preparing hydrate of bromal on the large scale by causing the vapours of bromine to pass into alcohol, care being taken to avoid an excess of the haloid, and thereby preventing the formation of bromated bromethyls, studied the substances resulting from this reaction by first submitting the raw product to distillation in a steam-bath, and next employing a sand-bath. By the steam-bath heat some bromide of ethyl, acetic ether, and solution of hydrobromic acid were driven off; while, by further heating, three different groups of bodies were obtained, viz.:—At from 100° to 130°, chiefly hydrated bromhydric acid; at from 165° to 180°, bromal and an oily substance insoluble in water; above 180°, some substances boiling with partial decomposition. From the distillate which came over at between 165° and 180°, bromal was separated by the admixture of water, and the hydrate of bromal obtained in a pure state by re-crystallisation. Bromal boils, without decomposition, at 173°, and is not congealed at −20°. The hydrate of bromal fuses at 53·5, cannot be distilled without decomposition, being converted into water and bromal, which latter, on being mixed with perfectly absolute alcohol, yields a bromal-alcoholate, a solid crystalline body, fusing at 44°, difficultly soluble in water, but readily so in alcohol and ether; on being submitted to distillation it is converted into alcohol and bromal. The formula of this alcoholate of bromal is $C_2Br_3OH+C_2H_6O$. A large portion of the further contents of this memoir is devoted to exhaustive researches on bibrom- and tribrom-acetic acid, and compounds and derivatives thereof.

Action of Phosphuretted Hydrogen upon the Iodides of Methyl and Ethyl.—Dr. A. W. Hofmann.—This very lengthy essay contains the account of a series of researches instituted by the author, in continuation of former experiments, on the preparation of phosphines. The essay, which contains the experiments in the methyl and ethyl series, is not well suited for useful abstraction.

Coal-Tar Cresols.—Dr. H. L. Buff.—Upon a portion of creosote boiling at from 204° to 205°, the author has caused chloride of benzoyle to act, thereby obtaining a solid and a liquid body. The former, a crystalline substance, fuses at 70°, and is, as regards its properties, identical with the benzoate of para-kresol obtained by MM. Latschinoff and A. Engelhardt; the liquid cresol is perfectly colourless, boils at 205°, and is stated by the author to be a para-kresol.

Some Combinations of Tolan.—Drs. Limpricht and Schwanert.—This is a preliminary notice of some researches, not yet finished, on the action of chlorine compounds and bromine upon tolan, which yields, it appears, several isomeric chlorides and bromides.

New Compounds of the Camphor Series.—Dr. I. Kachler.—This paper, a fragment of a large essay the author intends to publish, contains the record of some researches on the action of nitric acid upon camphor. It appears that not only camphoric and camphresic acids are formed, but also a fluid combination of camphor and nitric acid—a nitrate of camphor—and another peculiar acid. The nitrate of camphor, $2(C_{10}H_{16}O).N_2O_5$, is a rather unstable, liquid, oily compound, instantaneously decomposed by water, metals, and their oxides, ammonia, aniline, and phenol, but soluble, without decomposition, in alcohol and ether.

Thio-Aniline and Thio-Toluidine.—V. Merz and W. Weith.—This exhaustive and very lengthy monograph is not well suited for any useful abstraction.

Some of the Hydrocarbons of the Marsh Gas Series.—C. Schorlemmer.—The author gives a series of formulæ of hydrocarbons prepared by him, and the boiling-points of these substances, all of which are normal—that is to say, that the carbon-atoms are united in a simple manner.

Contribution to our Knowledge on Ditolyles.—Dr. Th. Zincke.—This paper, illustrated with woodcuts, strictly belongs to crystallography.

Researches on Valeraldehyde.—Dr. A. Schröder.—This essay contains the following sections:—Preparation and properties of valeraldehyde; action of chlorine upon valeraldehyde; sulpho-valeraldehyde and seleno-valeraldehyde.

Researches on the Sulphuretted Urea.—A. Arzruni.—The author describes, at great length, the mode of preparation of a sulpho-urea from amido-benzoic acid. The new body, $C_8H_9N_3O_2S$, named monoxy-benzoyl-sulpho urea, is insoluble in cold water, alcohol, and ether, but soluble in boiling water and alcohol. On being heated by itself, this new compound is decomposed, giving off sulphuretted hydrogen, and yielding oxybenzoyl-urea, $C_8H_8N_2O_2$. The relation which the monoxy-benzoyl-sulpho urea bears to other already known similar compounds is set forth by the following formulæ:—Monoxy-benzoyl-sulpho urea—

$$\left.\begin{matrix}(CS)''\\C_7H_5O_2\\H_2\end{matrix}\right\}N_2;$$

dioxy-benzoyl-sulpho urea—

$$\left.\begin{matrix}(CS)''\\(C_7H_5O_2)_2\\H_2\end{matrix}\right\}N_2;$$

monoxy-benzoyl-phenyl-sulpho urea—

$$\left.\begin{matrix}(CS)''\\C_7H_5O_2\\C_6H_5\\H_2\end{matrix}\right\}N_2.$$

Annales des Mines, No. 4, 1870.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

New Process for the Treatment of Gold and Silver Ores.—L. E. Rivot.—This very valuable monograph is divided into the following chapters:—Introduction; auriferous veins and lodes; argentiferous veins and lodes; amalgamation processes; laboratory experiments, conducted by MM. Regnault and Cumenge; first series of experiments on the action of steam upon simple native and artificially-prepared sulphurets, and upon complex sulphurets; action of super-heated steam upon these and other similar substances; combined action of super-heated steam and oxide of iron, or roasted pyrites mixed with the substances just alluded to; experiments on the large scale made in California; laboratory experiments on amalgamation and other metallurgical operations; observations on amalgamation, and the influence thereupon of oils, lime, and metals; metallurgical methods and apparatus. The essay is illustrated by a series of engravings.

Condensed Report of the Labours Performed at the Departmental Chemical Laboratory established at Mézières (Ardennes).—E. Nivoit and M. Létrange.—This paper contains, among other particulars, a series of analyses of phosphatic nodules (so-called coprolites) found in various localities of this part of France. It appears that the quantity of phosphoric acid contained in these nodules averages 18, does not exceed 22, and not fall below 13 per cent. Average composition of the metal of an old bell of Mézières, in 100 parts—Tin, 20·91; lead, 2·74; zinc, a trace; copper, 76·35. Cadmia from a blast furnace was found to consist, in 100 parts, of—Oxide of

zinc, 89·10; oxide of lead, 5·91; oxide of iron and alumina, 1·90; lime, 0·97; sulphuric acid, 0·13; silica, 0·56;—total, 98·57.

Memoir on the Principal Sites of the Mineral Lodes and Veins of Saxony and Northern Bohemia.—MM. Lévy and Choulette.—This essay is a very valuable contribution to the knowledge of the metallurgically-workable minerals in the countries named.

Report on the Official Inquiry on the Condition of the Miners and Factory Workers in Belgium.—M. Demongeot.

Bulletin de l'Académie Impériale des Sciences de St. Petersbourg, vol. xv., No. 4, 1870.

This number does not contain any papers relating to chemistry or allied sciences.

Vol. xv., No. 5, 1871.

The only papers relating to physical sciences in this number are:—

Preliminary Notice on the Application of Secondary or Polarisation Batteries to Electro-Magnetic Motors.—Professor Jacobi.—The author first enters at length into theoretical discussions on the various polarisation batteries, or substitutes therefor, proposed at various times by different physicists, more especially in England and France. The author next describes a polarisation battery made of leaden plates put into sulphuric acid (1·3 sp. gr.), and each having 900 centimetres' surface, the troughs (6·5 centimetres long by 6·3 wide and 13·6 high) being made of gutta percha. Of this kind of galvanic element the author employs fifty, and charges them by the aid of four large-sized Grove's or Bunsen's cells.

Micrographical Researches.—Dr. A. Stuart.—This paper, illustrated by woodcuts, contains a detailed description of a new and ingeniously-devised plan for the measurement of objects seen under the microscope.

Journal für Gasbeleuchtung und Wasserversorgung, No. 7, 1871.

The only matter relating to chemistry and collateral sciences met with in this paper is—

Oxygen, its Occurrence, Preparation, and Application for Illuminating Purposes; and on a New Method of Oxygen Illumination.—Dr. J. Philipps.—This periodical also contains a brief review of the work of the author just named, and recently published by him in German at Berlin. It appears that the carboxygen lamp invented by the author, and obtainable from the firm of Georg Berghausen, at Cologne, is, in every respect, a great success. The lamp need not be fed with pure oxygen, the author having found that an artificial air containing 50 per cent of oxygen yields light of the same intensity as pure oxygen. The lamp consumes, per hour, 4·8 English cubic feet of the gas just alluded to under a pressure of 30 m.m., and with a consumption of 20 grms. of a fluid the nature of which is not explained. The author's pamphlet is illustrated with woodcuts and two lithographic plates.

Journal fur Praktische Chemie, No. 5, 1871.

The greater portion of this number is filled with the continuation and end of the lengthy essay—

Contribution to our Knowledge of the Geminated (Gepaarten) Compounds of the Pentatomic Nitrogen.—C. W. Blomstrand. —See CHEMICAL NEWS, vol. xxiii., p. 597.

The only other paper, on the—

Products of the Acid Fermentation of Wheaten Bran—A. Freund—Contains the very detailed description of a series of experiments made by the author with the view of thoroughly investigating the various products of the acid fermentation of wheaten bran. The main results arrived at are, that this fermentation mainly produces lactic acid, but, in addition thereto, formic, acetic, butyric, and capronic acids are formed; but neither propionic nor valerianic acids are generated. The author states that he is engaged in making further researches on this subject, taking care to cause the process of fermentation to proceed at varying temperatures, in order also to find thus, if possible, a more expeditious and advantageous method of preparing propionic acid, instead of its preparation from cyanide of ethyl.

NOTES AND QUERIES.

Nitrobenzol.—Will any of your readers kindly inform me how best and safely to distil nitrobenzol so as to obtain it colourless?—MIRBANE.

Removing Sulphur from Coke.—(Reply to "R.")—You will find in Ronalds and Richardson's "Chemical Technology," vol. i., part i., p. 124, every information you desire on the subject; the quotation in our Notes and Queries would occupy too much space. The work referred to was published in 1855 by Messrs. Baillière. Consult, also, "Abridgements of all Specifications of Patented Inventions" (No. 30, Preparation and Combustion of Fuel), published by the Commissioners of Patents.

Removing Sulphur from Coke.—In reply to your correspondent, "R.," in Notes and Queries of your last issue, Professor Calvert patented, in 1851, a process for purifying coke similar to that described by him, the only difference being that the salt was mixed with the coal before coking in a solid form, instead of as brine. This process failed for the reason that, by the decomposition of the salt, sulphate of soda, and some other combinations of the sulphur and the sodium were formed (the chlorine escaping principally as hydrochloric acid probably), and by these means the sulphur, instead of being removed, was fixed in the coke. I am superintending the working out of a process, patented by my brother in 1868, for the removal of sulphur and phosphorus from coke and ores, and have obtained some good results from it. Calcination, or coking with common salt, is a feature in this process, but the ore and the coke are washed in water after the ignition. The compounds formed during the ignition being soluble in water, this effectually removes them.—F. J. ROWAN, Atlas Steel Works, Glasgow.

Alteration of Arsenious Acid.—Can any of your readers tell me if it is known as a fact that arsenite of potash in solution is liable to alteration on keeping? Eight years ago, I made a solution, containing 139·6 grs. in a decigallon, for chlorine testing for a friend—a paper maker. Half the quantity has stood for some years in a stoppered bottle, half full; and, on testing it yesterday against a freshly-prepared solution, I found a discrepancy of 5½°—the As_2O_3 had partly already become As_2O_5. If this is not a known fact, it may be useful to many of your subscribers to learn that, unless sufficiently freshly made, the arsenious acid solution is not an entirely reliable test. Though, regarding the amount of error introduced, and the time the solution had been kept, I should say that the error in one year would be hardly sufficient to impair its usefulness as a manufacturer's test.—JOHN S. LINFORD.

Welding of Cast-Steel and Iron.—In a well-known American paper, we find a notice on the subject of welding cast-steel together, which briefly comes to the following, and might, perhaps, be tried in the welding of steel to iron. The author, evidently a practical man, states that he first upsets the two ends that are to be welded considerably larger than the welded part is to be when hammered down to the proper size; next, split one of the ends of the bar a little deeper than the bar is thick, draw out the ends of the lips and narrow them up at the points, and draw out the end to be welded into this into a blunt wedge shape, narrowing the end also; next make, with a cold chisel, a cut on one side of the wedge-shaped end, in order to prevent it from slipping out when sticking them together, and afterwards heat the two ends that are to be united to a cherry-red heat, using common borax; unite them in the usual way, driving them together endwise, then, closing down the two lips with the hammer at a bright cherry-red heat, they will stick together; then put on plenty of borax, and heat in a charcoal fire to a point just above a bright cherry-red heat, but not to a sparkling heat as in welding iron.

MEETINGS FOR THE WEEK.

MONDAY, June 5th.—Royal Institution, 2. General Monthly Meeting.
TUESDAY, 6th.—Royal Institution, 3. Rev. Prof. Haughton, "On the Principle of Least Action in Nature."
—— Zoological, 9.
WEDNESDAY, 7th.—Microscopical, 8.
—— Geological, 8.
—— London Institution, 2. Distribution of Prizes and Certificates by the President, Thomas Baring, Esq., M.P.
THURSDAY, 8th.—Royal Institution, 3. Prof. Tyndall, LL.D., F.R.S., "On Sound."
—— Royal Society Club, 6.
FRIDAY, 9th.—Royal Institution, 9. Prof. Tyndall, LL.D., F.R.S., "On Dust and Smoke."
—— Astronomical, 8.
—— Quekett Microscopical Club, 8.
SATURDAY, 10th.—Royal Institution, 3. J. N. Lockyer, Esq., F.R.S., "On the Instruments Used in Modern Astronomy."
—— Quekett Microscopical Club. Excursion to Homerton; to meet at Broad Street Station at 2 p.m.

TO CORRESPONDENTS.

ERRATA.—In No. 600, p. 249, line 18 from bottom of left-hand column, *for* "$Tl_2PtCy_4,COTlO_3$" *read* "$Tl_2PtCy_4,COTlo_3$."
Page 250, line 5 from top of left-hand column, *for* "that no combination" *read* "that combination."
Page 250, line 2 from top of right-hand column, *for* "falls" *read* "fills."

A Subscriber.—A work on the subject, by the Editor, is in the press; it will be duly announced.

Subscriber.—The product cannot, we believe, be obtained in England.

A. Ridge.—We have received the white carbonate; what are our correspondent's wishes concerning it?

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THE CHEMICAL NEWS.

Vol. XXIII. No. 602.

NOTE ON THE

SPECTRUM OF URANUS AND THE SPECTRUM OF COMET I., 1871.*

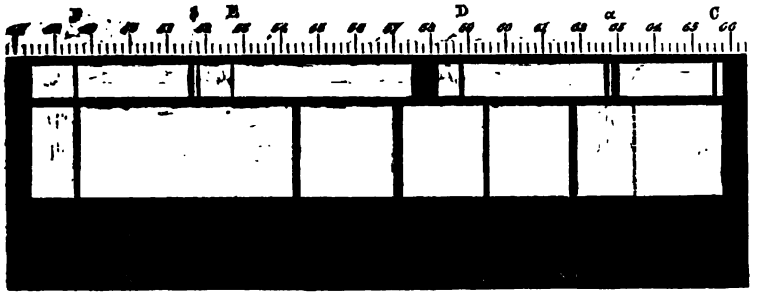
By WILLIAM HUGGINS, LL.D., D.C.L., V.P.R.S.

In the paper "On the Spectra of some of the Fixed Stars,"† presented conjointly by Dr. Miller and myself to the Royal Society in 1864, we gave the results of our observations of the spectra of the planets Venus, Mars, Jupiter, and Saturn; but we found the light from Uranus and Neptune too faint to be satisfactorily examined with the spectroscope.

By means of the equatorial refractor of 15 inches aperture, by Messrs. Grubb and Son, recently placed in my hands by the Royal Society, I have succeeded in making the observations described in this paper of the remarkable spectrum which is afforded by the light of the planet Uranus.

It should be stated that the spectrum of Uranus was observed by Father Secchi in 1869.‡ He says—"Le jaune y fait complétement défaut. Dans le vert et dans le bleu, il y a deux raies très larges et trés naires." He represents the band in the blue as less refrangible than F, and the one in the green as near E.

The spectrum of Uranus, as it appears in my instrument, is represented in the accompanying diagram. The narrow spectrum placed above that of Uranus gives the



relative positions of the principal solar lines, and of the two strongest absorption-bands produced by our atmosphere, namely, the group of lines a little more refrangible than D, and the group which occurs about midway from C to D. The scale placed above gives wave-lengths in millionths of a millimetre.

The spectrum of Uranus is continuous, without any part being wanting, as far as the feebleness of its light permits it to be traced, which is from about C to about G.

On account of the small amount of light received from this planet, I was not able to use a slit sufficiently narrow to bring out the Fraünhofer lines. The positions of the bands produced by planetary absorption, which are broad and strong in comparison with the solar lines, were determined by the micrometer and by direct comparison with the spectra of terrestrial substances.

The spectroscope was furnished with one prism of dense flint-glass, having a refracting-angle of 60°, an observing telescope magnifying 5½ diameters, and a collimator of 5 inches focal length. A cylindrical lens was used to increase the breadth of the spectrum.

The remarkable absorption taking place at Uranus shows itself in six strong lines, which are drawn in the diagram. The least refrangible of these lines occurs in a faint part of the spectrum, and could not be measured. Its position was estimated only, and on this account it is represented in the diagram by a dotted line. The positions of the other lines were obtained by micrometrical measures on different nights. The strongest of the lines is that which has a wave-length of about 544 millionths of a millimetre.

The band at 572 of the scale is nearly as broad but not so dark; the one a little less refrangible than D is narrower than the others.

The measures taken of the most refrangible band showed that it was at or very near the position of F in the solar spectrum. The light from a tube containing rarefied hydrogen, rendered luminous by the induction-spark was then compared directly with that of Uranus. The band in the planet's spectrum appeared to be coincident with the bright line of hydrogen.

Three of the bands were shown by the micrometer not to differ greatly in position from some of the bright lines of the spectrum of air. A direct comparison was made when the principal bright lines were found to have the positions, relatively to the lines of planetary absorption, which are shown in the diagram. The band which has a wave-length of about 572 millionths of a millimetre is less refrangible than the double line of nitrogen which occurs near it. The two planetary bands at 595 and 618 of the scale appeared very nearly coincident with bright lines of air. The faintness of the planet's spectrum did not permit of certainty on this point; I suspected that the planetary lines are, in a small degree, less refrangible. There is no strong line in the spectrum of Uranus in the position of the strongest of the lines of air, namely, the double line of nitrogen.

As carbonic acid gas might be considered, without much improbability, to be a constituent of the atmosphere of Uranus, I took measures with the same spectroscope o the principal groups of bright lines which present themselves when the induction-spark is passed through this gas. The result was to show that the bands of Uranus cannot be ascribed to the absorption of this gas.

There is no absorption-band at the position of the line of sodium. It will be seen by a reference to the diagram that there are no lines in the spectrum of Uranus at the positions of the principal groups produced by the absorption of the earth's atmosphere.

Spectrum of Comet I., 1871.

On April 7 a faint comet was discovered by Dr. Winnecke. I observed the comet on April 13 and May 2. On both days the comet was exceedingly faint, and on May 2 it was rendered more difficult to observe by the light of the moon and a faint haze in the atmosphere. It presented the appearance of a small faint coma, with an extension in the direction from the sun.

When observed in the spectroscope, I could detect the light of the coma to consist almost entirely of three bright bands.

A fair measure was obtained of the centre of the middle band, which was the brightest; it gives for this band a wave-length of about 510 millionths of a millimetre. I was not able to do more than estimate roughly the position of the less refrangible band. The result gives 545 millionths. The third band was situated at about the same distance from the middle band on the more refrangible side.

It would appear that this comet is similar in constitution to the comets which I examined in 1868.*

* Read before the Royal Society, May, 1871.

† *Phil. Trans.* 1864, p. 413; and for Mars, *Monthly Notices R. Ast. Soc.*, vol. xxvii., p. 178.

‡ *Comptes Rendus*, vol. lxviii., p. 761, and *Le Soleil*, Paris, 1870 p. 354.

* *Phil. Trans.* 1868, p. 555; and *Proc. Roy. Soc.*, vol. xvi., p. 386.

ON A

NEW METHOD OF PREPARING SUPER-SATURATED SALINE SOLUTIONS.

By L. C. De COPPET, Ph.D.

IN 1868-69 I made, in the laboratory of the Royal College of Chemistry, a series of experiments on supersaturated solutions, of which the following are some of the results.*

Supersaturated solutions of sodic sulphate are usually prepared by cooling, in closed vessels, solutions saturated at a higher temperature.

I have found that so-called supersaturated solutions of sodic sulphate may be prepared at ordinary temperatures by simply dissolving the anhydrous salt in cold water.

To ensure the success of the experiment it is necessary to protect the solution from contact with the dust floating in the atmosphere. The anhydrous salt itself must be rendered "inactive" if for any length of time it has been exposed to the air. This is done by heating it to a temperature above 33° C. (I have found 40° C. sufficient, but it is safer to heat as high as 100° or 200°) and cooling in a closed vessel.

The salt must be added to the water in small quantities at a time, first, because the heat evolved by its contact with the water would otherwise be sufficient to raise the temperature several degrees, and it might be objected that this was the cause of the supersaturation; secondly, because the salt, if added all at once, forms a hard cake which dissolves but slowly.

The greater part of my experiments were conducted in the following way:—The salt was put into a short wide tube sealed at one end, drawn out and bent at right angles at the other, so as to pass, together with a thermometer, through the neck of a small flask. When this tube containing the anhydrous salt had been heated and cooled in order to render the salt "inactive," and the flask well washed and half-filled with cold water, the narrow end of the tube was introduced into the flask (not so far as to touch the water), and the space left between it, the thermometer, and the neck of the flask filled with cotton-wool. By gently shaking the tube, the salt would fall into the water, a very little at a time, and dissolve, without sensible rise of temperature, in much larger quantities than the ordinary crystallised salt ($Na_2SO_4,10H_2O$).

If the flask is placed in a large water-bath, the temperature may be kept very nearly constant throughout the experiment.

On one occasion, the temperature of the water at the beginning of the experiment was 13·5° C. Salt was added, and the flask often shaken, to hasten the solution, without being withdrawn from the water-bath. In two hours the temperature had slowly risen to 14°, and it being then evident that no more salt was dissolved—in other words, that the solution was saturated with anhydrous sodic sulphate—a portion of the perfectly clear menstruum was poured into several clean dry flasks, each provided with a cork. Two of these flasks I succeeded in weighing before the solution crystallised, and found both times that the strength of the solution was 35·8 parts of anhydrous sodic sulphate (Na_2SO_4) to 100 water. The concentration of this solution was, therefore, nearly three times that of the ordinary solution saturated with the normal salt—

$$Na_2SO_4,10H_2O,$$

which, at 14° C., contains 12·4 parts anhydrous salt to 100 water.

Another experiment showed the solubility of anhydrous sodic sulphate at 21° C. to be very nearly 52·7 parts of Na_2SO_4 to 100 water; the solubility of the hydrate—

$$NaSO_4,10H_2O,$$

at the same temperature is but 20·9 parts anhydrous salt to 100 water.

These experiments show that an ordinary saturated solution of anhydrous sodic sulphate is identical with what is commonly called a supersaturated solution. Of course I do not mean to imply by the words "solution of anhydrous sodic sulphate" that the salt *in* the solution is in the anhydrous state.

It is now very generally admitted that crystals of the 10-atom salt ($Na_2SO_4,10H_2O$) always bring about the solidification of a supersaturated solution of sodic sulphate. Among the many who of late years have investigated the subject, Mr. Tomlinson is, I believe, the only one who holds the opposite view.

Completely effloresced Glauber's salt, though anhydrous, also invariably causes crystallisation.

It would seem from this that anhydrous sodic sulphate, prepared by drying crystals of $Na_2SO_4,10H_2O$ at temperatures below 33° C. is not identical with that prepared by heating at temperatures above 33°. They are, probably, isomeric modifications. The former, whether anhydrous (effloresced) or combined with 10 atoms water, always causes the supersaturated solution to crystallise; the latter, whether anhydrous or combined with 7 atoms of water not only never does so, but may be dissolved in a solution already highly supersaturated.

Supersaturated solutions of sodic carbonate and of magnesic sulphate may be prepared without heating in the same manner as those of sodic sulphate. I used for the purpose anhydrous sodic carbonate and partially dehydrated magnesic sulphate.

* A more detailed account of the experiments here referred to was published early in 1869 in the *Bulletin de la Société vandoise des Sciences Naturelles*, vol. x., p. 145.

ON A METHOD OF

FIXING, PHOTOGRAPHING, AND EXHIBITING THE MAGNETIC SPECTRA.*

By ALFRED M. MAYER, Ph.D.

THE figures produced in iron-filings, when these are set in momentary vibration on a surface placed over a magnet have received considerable attention from natural philosophers. The geometrical discussion of these spectra made by Lambert, Roget, and others, have developed their symmetrical properties, and thereby have evolved the law of that action which emanates from the magnet. De Haldat has used them as a means of exploring the distribution and intensity of the effect of juxtaposed magnets variously arranged. But, above all, have the researches of Faraday and W. Thomson on "the magnetic field," and on "the lines of magnetic force" given to these spectra—even when merely regarded as conventional symbols—an importance which has been fully shown; especially by Faraday, who was guided by their consideration to some of his most important discoveries. They have thus risen to so high a theoretical importance that a method which will fix them without danger of distortion, photographically reproduce them, and readily serve to exhibit them to the largest audiences, will, I imagine, be acceptable to both investigators and lecturers.

The only process of fixing these spectra known to me is that practised by De Haldat and Faraday, which, however, is but an application of the magnetic spectra of the method previously invented by Savart for preserving the Chladni figures of vibrating plates. In this process the spectra, produced in the usual manner either on glass or card-board, have pressed upon them a sheet of paper coated with mucilage, to which the filings adhere. In this operation of the transfer many particles are deranged from their positions and the figures are yet more distorted by the shrinkage of the wet paper, and are therefore not fit to

* See a neat "Démonstration par le calcul des courbes magnétiques de le loi de l'inverse du carré de la distance," by M. Cellerier, published as a note on p. 592, vol. i., of De la Rive's Traité d'Electricité.

serve in measures of precision; while the impressions cannot be exhibited with much more facility than the originals.

My process is as follows:—a clean plate of thin glass is coated with a firm film of shellac, by flowing over it a solution of this substance in alcohol,* in the same manner as a photographic plate is coated with collodion. After the plate has remained a day or two in a dry atmosphere, it is placed over the magnet, or magnets, with its ends resting on slips of wood, so that the under surface of the plate just touches the magnet. Fine iron-filings, produced by "draw-filing" Norway iron which has been repeatedly annealed, are now sifted uniformly over the film of lac by means of a fine sieve. The spectrum is then produced on vibrating the plate, by letting fall vertically upon it, at different points, a light piece of copper wire. The plate is now cautiously lifted vertically off the magnet and placed on the end of a cylinder of pasteboard, which serves as a support in bringing it quite close to the under surface of a cast-iron plate (1 foot in diameter, ½ inch thick), which has been heated over a large Bunsen-flame. Thus the shellac is uniformly heated, and the iron-filings, absorbing the radiation, sink into the softened film and are "fixed."

I generally allow the heat to act until the metallic lustre of the filings has disappeared, by sinking into the shellac, and the film appears quite transparent. This degree of action is necessary when photographic prints are to be made from the plate, but when they are to be used as lantern slides I do not carry the heating so far. After the plate has cooled, it is allowed to fall upon its ends, on a table, so that any filings which have not adhered may be removed.

A short experience will give the proper strength of shellac solution to obtain a film so thick as *just to be sufficient to hold the filings*, and the requisite amount of heat to firmly cement them, without injuring the transparency of the film.

The plates can now serve (1) for the most accurate measures upon the magnetic field; (2) for a photographic positive, which, in the printing-frame will produce the lines in white upon a dark ground, giving most beautiful and distinct impressions;† (3) or, if it is required to exhibit these figures to an audience, the plates are provided with glass covers, kept from touching the spectra by intervening slips of cardboard, and there result "slides," in every way fit for giving a fine exhibition, when the images are projected upon a screen. I have thus obtained images, clear and sharp, of over 12 feet in diameter.

By this process many plates have been produced;‡ showing the action of single magnets of various forms, and of juxtaposed bars; as well as the effects of electric currents led by wires through holes drilled in the plates. Those exhibiting the inductive action of magnets on bars of soft iron and the interaction of magnets and electric currents are peculiarly interesting. An approximate representation of the resulant lines of the terrestial magnetic action has been obtained by magnetising *equably tempered* steel discs of from 2 to 3 inches and even more in diameter. The magnetic axis or axes of these discs are *predetermined* by making them the continuations of the axes of very powerful electro-magnets, terminated with cones of soft iron with slightly rounded apices. The arcs of the great circles, including the terrestrial magnetic poles, having been calculated, the axes of the electro-magnets are inclined to that angle, while the steel disc is held close to their poles. On passing the current the disc is magnetised and we have an approximate representation of a section of the earth's magnetic effect. These results when viewed as photographic prints, or, as exhibited by the lantern, are so beautiful and instructive as to appear to me to warrant this somewhat formal description of the process of their production.

PS. Since sending the above to press I have subjected plates, coated with "sensitised" collodion to the action of the magnetic field. I had hopes of thus obtaining a *physical* impress on the plate which would appear on flowing the "developer." Sensitised films on glass and on iron plates were placed over and between the poles of an electro-magnet with cores 1·7 inches in diameter. Some plates were developed after removal from the magnet, others while under the magnetic action—with and without the light having acted upon them—but no trace of effect has been detected.

I had also imagined that the magnet's action should have placed the affinities in a more unstable condition, so that the film would rise in sensitiveness after exposure in the magnetic field; but this, also, I could not detect; nevertheless, I have not given up the supposition that some action will be evolved when more appropriate films, far higher magnetic action, and more delicate measures of actinic effect are used.—*American Journal of Science.*

* The shellac dissolved in strong alcohol is allowed to stand a week or more, and the clear supernatant solution is then decanted.

† Photographic prints from a series of eight of these plates I have presented to Harvard College: American Academy of Sciences; Sheffield Scientific School; Columbia College; Stevens's Institute of Technology, Hoboken; Lehigh University, Pa.; American Philosophical Society; Franklin Institute; Peabody Institute, Balt.; Smithsonian Institution; Chicago Academy of Sciences; and to the University of Virginia.

‡ Several of these are 16 inches long by 10 wide.

ON THE

EFFECT OF CERTAIN METALLIC SUBSTANCES BESIDES IRON ON CARBONIC OXIDE, INCLUDING SILICON.*

By I. LOWTHIAN BELL.

(Concluded from p. 260).

Cobalt.

A COBALT oxide was prepared from the purified nitrate in the same way as the oxides of nickel above described.

It was almost pure Co_3O_4 (Co 73·5, O 26·5), its composition being—

Co	73·3
O	26·7

A small trace of Ni might be present, but if so, it could not materially affect the result, inasmuch as CoO is much more powerful in splitting up CO than is NiO.

Specimens of this oxide of cobalt (Co_3O_4), were exposed in the lead-bath arrangement.

		Expt. 399.	*Expt.* 400.
Time of exposure—		7½ hours.	10 hours.
Temperature—		Zn fused, Sb not	Zn fused, Sb not.
Composition of product.	Co soluble in I	47·2	17·3
	Co insoluble in I		20·4
	Carbon	46·4	56·8
	Oxygen	6·4	5·5
		100·0	100·0

The condition in which the cobalt exists was not determined—that is, whether part as metal and part as oxide, or whether the whole was as suboxide. In Experiment 399, the oxygen per 100 of total cobalt present was 13·56, and in Experiment 400 14·58, which correspond nearly with Co_2O (100 Co, 13·6 O). It was ascertained that the anhydrous Co_3O_4 used was attacked by iodine and water, so that it was not possible by the use of this reagent, as in the case of iron and nickel, to distinguish between metallic cobalt and its oxide. The oxygen in Experiment 400 existed to the extent of 27·0 per 100 parts of that cobalt which was found to be insoluble in iodine and cold water, which indicates that the action of iodine on the Co_2O probably formed gives rise to CoO, and not Co_2O_3; the former formula requiring 27·1 of O per 100 of Co, thus:—

$$Co_2O + I_2 = CoI_2 + CoO,$$

* From the "Chemical Phenomena of Iron Smelting."

which indicates a double difference between the behaviour of the lower oxides of Co and Fe under these circumstances. The fact that the Co_3O_4 originally used was attacked by iodine, however, probably indicates that Co_2O_3 is producible by the action of iodine on the lower oxides; a reaction probable, *à priori*, from the well-known formation of Co_2O_3 from the action of chlorine on alkalised solutions of cobalt.

The presence of CO_2 to the extent of an equal volume does not prevent CO from completely reducing the cobalt oxide under examination (Co_3O_4).

Expt. 401.	*Expt.* 402.
Temperature—Dull red.	Temperature—Bright red.
O lost, in 2½ hours, 26·5 per ct.	O lost, in 3 hours, 26·6 per ct.
3 ,, more, 0·1 ,,	
26·6 ,,	

the original oxygen being 26·7 per cent.

The effect of cobalt in its metallic state was next tried on pure CO, the Co being obtained by acting on Co_3O_4 by H, until no more H_2O was formed.

		Expt. 403.	*Expt.* 404.
Time of exposure—		5 hours.	4½ hours.
Temperature—		Melting zinc.	Low red heat.
Composition of product.	Co	98·3	99·7
	C	1·4	0·1
	O	0·3	0·2
		100·0	100·0

To ascertain the power of the spongy metallic cobalt to withdraw O from CO_2, in—

Expt. 405.—120 c.c. of gas unabsorbed by KaHO was collected by passing CO_2 over Co at a bright red heat for thirty-five minutes. The 120 c.c. so obtained contained 96 per cent of CO.

Platinum—

Although there was little probability of a metal having so feeble an affinity for oxygen as platinum to exert any power of splitting up CO, the following experiments were performed, under the idea that possibly the dissociation of CO by heat alone (which Experiment 373 *et seq.* show, does not readily take place), might be assisted by the occlusion of that gas in the pores of a spongy substance gifted with high absorbing powers for gases.

This metal was obtained in its spongy condition—

(A) by ignition of ammonium chloroplatinate.
(B) ,, potassium chloroplatinate and washing product.

Expt. 406.—Spongy platinum (A), inert, at melting zinc.
Expt. 407.— ,, ,, ,, ,, low red heat.
Expt. 408.— ,, ,, (B), ,, melting zinc.
Expt. 409.— ,, ,, ,, ,, low red heat.

In one of these cases there was a trace of carbonaceous matter deposited, due, probably, to the presence of hydrocyanic acid vapour in the CO employed, as the gas used was not wholly freed from this impurity.

Silicon—

Expt. 410.—A specimen of this element, in its graphitoidal form, weighing 1·405 grms., dried at 100° C. (212° F.), lost .. .. 0·005
Just ignited, and lamp removed, lost .. .. 0·013
0·018
Then heated to redness for half an hour, it gained .. .. 0·006
Ditto, half an hour more, it gained .. .. .. 0·004
0·010

The substance then contained some body, probably carbon, which exposure to air at a red heat removed, and some modification of silicon, oxidisable at this temperature.

The 1·397 grms. of silicon remaining after this treatment were exposed to a stream of pure CO for six and a half hours, at a temperature a little above that of melting zinc :—

No change in weight.

Expt. 411.—The same specimen was then exposed to CO at a bright red for a period of six hours, precautions, before and after the experiment, in both cases, being observed to exclude atmospheric air :—

	Per cent
The gain in weight was	0·18
Burnt in oxygen, gain on original substance was	0·29
CO_2 collected = 0·08 grm., equal to C	0·15

Looking at the previous behaviour of this specimen of graphitoidal silicon, it is doubtful whether this small quantity of C is owing to carbon deposition, but may rather be due to trace of C or graphite in the silicon itself.

Titanic Acid—

Expt. 412.—Cubical crystals of nitride of titanium are commonly found in the hearths of extinguished blast-furnaces. The specimen of amorphous TiO_2 employed was obtained by igniting ammonium titanate: 0·464 grm. was exposed for six and a half hours to a temperature a little above that of melting zinc. The TiO_2 was faintly blackened on its surface :—

	Per cent.
The gain in weight was	1·2
Burnt in oxygen, it lost again	1·0
CO_2 collected 0·019 = C on original TiO_2	1·1

Expt. 413.—The specimen of TiO_2, freed from carbon by ignition in O, would consist of—

	Grm.
Ti	0·283
O	0·181
	0·464

It was exposed to a bright red heat for six hours to a stream of pure CO. It was ascertained, by combustion in oxygen, collection of CO_2, and difference of weight, to be now composed of—

Ti	0·2830
C	0·0040
O	0·1725
	0·4595

From these numbers, it appears that the TiO_2 has lost 4·7 per cent of its oxygen, and deposited carbon to the extent of 0·9 per cent of the TiO_2 used, or 1·19 per cent of the metallic Ti present.

ON THE

METHODS OF ANALYSIS AND THE COMPOSITION OF VARIOUS CHEMICAL MANUFACTURING PRODUCTS.

By M. GASTON TISSANDIER.

Palm Oil.

Palm oil is prepared from the fruit of the palm tree (*Clæis Guineensis*) as follows :—On its arrival at maturity, the fruit is plucked and thrown into a heap on the ground, where it is left for about a month. Fermentation is thus produced. When this is sufficiently advanced, the mass is thrown into large iron vats and boiled with water, the fruits being crushed in the hands of the labourers from time to time. After prolonged boiling, they are pounded in rude mortars formed from the trunks of trees, the kernels are removed, and the shells again boiled. The oil then floats on the surface of the liquid, and is collected with large wooden spoons.

Properties.—Palm oil is solid at the ordinary temperature of our climates, its colour is a reddish yellow, and it is esteemed in proportion to the deepness of its colour. Its perfume resembles that of the iris or the violet. It melts at from 30° to 35° C., according to its age, but when freshly prepared its melting-point is lower. It is easily soluble in alcohol, and still more so in sulphide of carbon and ether. About 80,000 tons are annually manufactured. The oil mixes readily with water, which is frequently used to adulterate it: 50 per cent may be added without fear of detection by the most practised eye. In order to estimate the water contained in palm oil, a certain weight of it must be heated on a stove at 110° C.; desiccation will then ensue in a few hours. Unadulterated commercial palm oil contains from 3 to 8 per cent of moisture. A very superior quality of oil is obtained from the kernels of the palm, which are very large.

Ash.—Sand or earth is frequently mixed with palm oil during manufacture; to estimate this, calcine 50 grms. of oil in a porcelain capsule, and after the charcoal thus formed is burnt off, weigh the ash obtained. Palm oil sometimes contains from 4 to 5 per cent of sand.

Impurities.—Sundry organic substances, such as the remains of palm leaves, &c., also occur; in order to estimate these, melt 100 grms. of oil in a capsule upon a water-bath, let it stand an hour, decant the limpid oil, and treat the precipitated impurities with sulphide of carbon, so as to dissolve the oil which adheres to the sides of the vessel. The impurities must be thrown on a filter, washed with sulphide of carbon, dried at 100°, and weighed. Some analyses are subjoined:—

Loss in Palm Oil.

	I.	II.
Moisture	8·25	3·12
Ash	0·45	1·20
Organic impurities.. ..	1·01	0·80
Total loss	9·71	5·12

White-Lead—Zinc-White.

Commercial white-lead is frequently adulterated with sulphate of baryta, carbonate of baryta, and carbonate of lime. The presence of sulphate of baryta may be tolerated when its proportion does not exceed 5 per cent.

The mode of analysis is as follows:—Weigh 1 grm. of white-lead, and calcine it in a small porcelain capsule; treat the residue, while hot, with pure nitric acid diluted with water—this dissolves the oxide of lead, while the sulphate of baryta remains insoluble.

Now filter, and precipitate the filtered liquid with sulphuretted hydrogen; a formation of sulphide of lead will then ensue, and this must be dried at 100° C. and weighed. The liquid, separated from the sulphide of lead, is treated with ammonia and sulphhydrate of ammonia, which will betray the presence of oxide of zinc, which sometimes occurs in white-lead, by precipitating it as sulphide of zinc. Filter this latter, and evaporate the filtered liquid to dryness, previously adding chlorhydric acid; take up the residue with water and chlorhydric acid, and add ammonia and oxalate of ammonia, which will precipitate the lime as insoluble oxalate of lime.

The sulphide of lead is converted, by calculation, into carbonate; the sulphide of zinc is dissolved in chlorhydric acid after calcination, and precipitated as carbonate of zinc by the addition of carbonate of soda. The carbonate of zinc is collected on a filter, washed with boiling water, dried, calcined, and weighed; the calcination transforms it into oxide of zinc, which is thus extracted directly from the specimen of colour under examination.

To ascertain whether the white substance which was insoluble in the acid liquid used in the first experiment be really sulphate of baryta, proceed as follows:—Mix it thoroughly with dry, pure, finely-powdered carbonate of soda; heat it to redness in a platinum crucible, until the fluid mass no longer effervesces; let it cool, and boil it with warm water, which dissolves the sulphate of soda formed, without acting upon the carbonate of baryta which is formed during the reaction. The aqueous solution should be precipitated by chloride of barium, which determines the formation of insoluble sulphate of baryta; the insoluble substance remaining on the filter is treated with pure chlorhydric acid diluted with water, and should yield a precipitate of sulphate of baryta on the addition of a drop of sulphuric acid.

Occasionally, but rarely, kaolin and clay are met with in white-lead.

The white-lead to be tested is not invariably met with in powder; the specimen may be mixed with oil and turpentine; sometimes its adulteration is not suspected till after its application to walls or wainscoting. In the first case, in calcining the well-mixed paint, take no notice of any oil that may be burnt. In the second, scrape the paint off the wall, and treat it in the same way; care must be taken not to scrape the stone also; it is better to pay attention to the sulphate of baryta only, neglecting any carbonate of lime which may result from the calcareous wall.

Composition of Adulterated White-Lead.

Substances estimated.	I.	II.
Carbonate of lead	85·25	44·33
Oxide of zinc	—	5·30
Sulphate of baryta	10·12	40·25
Carbonate of lime	4·63	10·12
Clay	—	—
	100·00	100·00

Specimen No. II. is by no means the most adulterated with which we have met. Some months ago, a so-called white-lead was analysed by us which contained no trace of lead; it consisted of carbonate of lime and sulphate of baryta, the oil and turpentine being replaced by soap-suds.

Zinc-white is subject to the same adulterations as white-lead, and the analytical process for oxide of zinc is the same as for white-lead.

Water used for Feeding Boilers.

All who have the management of steam-engines must have been inconvenienced by their boilers becoming incrusted with deposits, or corroded by nitrous vapours or chlorhydric acid, arising from impurities in the water employed. Water of good quality, such as river water, spring water, and that of streams, seldom contains in solution more than from 1 to 3 decigrms. per litre of saline matter; this generally consists of carbonate of lime, alkaline chlorides, sulphate of lime, and a small quantity of organic matter.

When water contains much carbonate of lime, say 5 to 10 decigrms., it will encrust the boiler, forming a hard and injurious deposit; this is a *calcareous* water. If it contains much sulphate of lime, say 1 grm., it will leave an abundant deposit, and will not cook vegetables or dissolve soap; this is a *selenitic* water. Lastly, if it contains nitrate of magnesia or chloride of magnesium, it produces nitrous vapours and chlorhydric acid, which corrode the metal; this is a *corrosive* water.

To ascertain whether the above-mentioned substances are contained in a water, pour 1 litre of it into a very clean, deep dish, and evaporate it to dryness over the water-bath at 100° C. The residue must be carefully scraped off the dish with a platinum spatula, swept together with a brush, and weighed; its weight will give some notion of the quality of the water, which is pure in proportion to the smallness of the deposit.

Nitrate of Magnesia and Chloride of Magnesium.—The dry residue is weighed, and extracted with alcohol at 40°; this dissolves only the chloride and nitrate of magnesia and a small quantity of alkaline chlorides. Filter, wash with alcohol, and evaporate the alcoholic solution to dryness over the water-bath on a platinum capsule.

Heat the residue gradually at a higher temperature; if red nitrous vapours appear, it contains nitrate of mag-

nesia; if the vapours are white and acid, and form a thick white cloud upon contact with a glass rod moistened with ammonia, they consist of chlorhydric acid. In both these cases, the water is corrosive, and on its evaporation will attack metals. After completing the calcination, filtering off the resulting magnesia, and carefully weighing it, it may be changed by calculation into nitrate of magnesia or chloride of magnesium.

This method is far preferable to the direct estimation of the magnesia in water; for water may be magnesian without being corrosive, as all salts of magnesia do not thus yield acids when subjected to heat. Here the acids are plainly perceived, and the corrosive action is proved.

Chlorine.—Measure 1 litre of the water to be tested, and precipitate the chlorine by a slight excess of nitrate of silver, collect the chloride of silver on a filter, and wash it with boiling water. After drying on a stove, fuse partially in a small tared porcelain capsule, weigh it, and calculate the quantity of chlorine contained.

Sulphuric Acid.—Precipitate 1 litre of water by chloride of barium. The sulphuric acid is precipitated as sulphate of baryta.

Lime.—Precipitate 1 litre of water with oxalate of ammonia, and all the lime will be precipitated as oxalate of lime.

The sulphuric acid is transformed into sulphate of lime, and the excess of lime calculated as carbonate of lime.

The estimation of these substances may be directly verified by working upon the dry residue which was exhausted by the alcohol. That portion which is insoluble in alcohol is treated with water, which dissolves the chlorides and alkaline sulphates, and leaves the carbonates of lime and magnesia, sulphate of lime, and silica in an insoluble state.

That part of the residue which is insoluble in water must be treated with acetic acid, which dissolves only the carbonate of lime, and does not attack the sulphate. Evaporate the acetic solution to dryness, calcine the residue, and all the carbonate of lime contained will be reproduced. By evaporating the aqueous solution, the alkaline chlorides and sulphates are obtained; it is, therefore, obvious that by a succession of solvents it is possible to separate all the contained salts, and in some measure to isolate them.

It need scarcely be said that these methods are only intended to be practically and expeditiously applied by operators, and that no attempt at a mode of completely analysing water is here contemplated.

Some estimate of the purity of water may be gained by simply examining the precipitates yielded with nitrate of silver, chloride of barium, and oxalate of ammonia. Pour these three reagents successively into a water of good quality, and the cloudiness will be slight; repeat the process with *selenitic* well-water, and abundant white precipitates will ensue, due to the action of the chloride of barium and oxalate of ammonia.

Hydrotimetry.—This method, which has been much over-rated, is far inferior to that above described. It is based upon the action of water upon a standard alcoholic solution of soap. This solution is poured into the water, drop by drop, by means of a burette, and well shaken at each addition, ceasing when a persistent froth is formed; the number of divisions of the burette gives the hydrotimetric standard. Unfortunately, when water is very much charged with sulphate of lime, it *immediately* yields a persistent froth; and I am now in possession of well-water which, containing 1·20 grs. of sulphate, should estimate more than 100°, whereas the soapy froth is persistent at 8°. The latter figure indicates that the water is excellent, while it is really execrable.

Purification.—When water contains much bicarbonate of lime, it may be freed from a portion of it by adding milk of lime, which will precipitate insoluble carbonate of lime. If the water to be purified be placed in large reservoirs, and agitated while the milk of lime is poured in, it will be found, when it has settled, to contain much less bicarbonate of lime. The action of lime also removes the corrosive properties of water; the lime, in fact, changing chloride of magnesium into chloride of calcium, which does not decompose under the influence of heat, and transforming nitrate of magnesia into nitrate of lime, which decomposes only at a very high temperature, and may be evaporated without evolving nitrous vapours. These reactions are, however, difficult to bring into practice, and unsuited to the purposes of manufacture.

MANUFACTURE OF SODA AND CARBONATE OF SODA FROM CRYOLITE.*

By J. LAWRENCE SMITH.

MANY and vain have been the attempts to supersede the process of Leblanc for the production of soda, and vast amounts of ingenuity and capital have been expended without success. But this statement does not apply to the production of soda, to a limited degree, out of a curious mineral found in Greenland called cryolite. This mineral was exhibited in abundance at the Exposition, and as there is an important manufacture of soda from it established at Natrona, Pennsylvania, the details of the method employed will be briefly described. These details have been kindly furnished to me by J. A. Hagemann, the chemist of the Danish Cryolite Mining Company, who directs at this time the manufacture of soda from cryolite by the Pennsylvania Salt Manufacturing Company. We may look for the best information on the subject of the above-named company's works, which are imitations on a large scale of the factory built by Julius Thomsen, of Copenhagen, in 1856. Some information has also been obtained from an essay by Samuel F. Simes.

Cryolite and its Source.

Before proceeding to a description of the process of manufacture, it is well to give some short account of this mineral and its present commercial movement.

The mineral cryolite, or "ice stone," has been known as a mineralogical rarity for many years, as far back as the latter part of the last century; thirty years ago it was worth fully a dollar an ounce, and it was considered only as a rare and curious mineral, of no value in the arts. Up to 1850 no attempt had been made to put it to any practical use, although it was known to exist in Greenland in large quantities and to contain a large amount of soda, for its composition is—

3 Sodium	69·00
2 Aluminium	27·26
6 Fluorine	114·00
	210·26

It has a specific gravity of 2·95, with a hardness of 2·05. Much of it is found colourless and pure. The associated minerals are galena, blende, spathic iron ore, iron pyrites, and copper pyrites.

With the exception of some few scattered specimens that occur at Miask, in the Ural mountains, it is found exclusively in immense quantity. It is procured from the mines of Ivigtout on the west shore of South Greenland, on Arsuk Fiord, between Julian's Hope and Frederick's, latitude 61° north, longitude 48° west. The main deposit here forms a mass of 600 feet in length, and 200 feet in width, and descending to an unknown depth. It lies at the base of granite hills, that rise a little distance from the edge of the Fiord, the shores of which are very bold and are almost fathomless a few feet from the shore.

The Danish Government is the owner of this mine, and in 1864 Christian IX. granted the exclusive right of mining

* From the Report of the United States Commissioner to the Paris Exposition.

cryolite to the "Cryolite Mining Company of Handelshelhabet," a company organised in Copenhagen. This contract was made by a Danish company, in consequence of the results of the labours of a young Danish chemist, Julius Thomsen, in 1850, who discovered a cheap and easy method of rendering cryolite available in technical chemistry for the manufacture of soda and alum, and his process is carried on in Europe and this country on such a scale as to consume annually 12,000 to 15,000 tons of cryolite.

Process of Decomposing Cryolite.

Thomsen's process of decomposing cryolite is simply by lime, either the wet or dry way. The decomposition may be represented by the following formula:—

$$2(Al_2Fl_3+3NaFl+6CaO)=$$
$$=3NaO+2Al_2O_33NaO+12FlCa.$$

Another method is to calcine finely-powdered cryolite and mix it with six equivalents of lime; the product will be "caustic soda, aluminate of soda, and fluoride of calcium." Another is to boil cryolite with the same proportion of lime in the form of milk of lime, and a similar decomposition takes place. The soda and aluminate are soluble in water; the latter is subsequently decomposed by carbonic acid. Both the wet and dry process will now be described.

The Dry Process.—The cryolite is dried in a furnace, and by a crusher is reduced to small fragments, which are ground in a burrstone mill to a fine powder, and uniformity in the powder is insured by passing it through a bolter of fine wire gauze. The powder is then mixed with slaked lime, or with pulverised chalk, in proportion to its purity, so that for each equivalent of pure cryolite there shall be a little more than six equivalents of lime. This mixture is effected on chaser mills, such as are used for crushing linseed and other oily grains. This mixture is now calcined, and here arises the great difficulty of the process, for the soda or carbonate of soda and fluoride of calcium fuse at a low temperature, and if allowed to fuse would almost entirely prevent the subsequent lixiviation with water. Care must therefore be taken to prevent the temperature from rising high enough to fuse the mass, while at the same time the mass must be heated sufficiently to effect the decomposition.

When the factory at Copenhagen was erected in 1856, this decomposition was effected in iron retorts similar to gas retorts, and set in the same way, and the carbonic acid so liberated (when chalk was used) was conducted to the vats to decompose the aluminate of soda from a previous operation. But this process entailed costly repairs, and much expensive handling. Thomsen then constructed a furnace, which is now successfully used in all the cryolite factories.

It contains two fire-places at opposite ends. The flame from one of them passes *underneath* the hearth, which is formed of large slabs of fire-clay 2 feet square, and supported on square pillars. At this farther end, the flame meets the other, and both pass *over* the hearth, then rise and pass over the arch, and under an evaporating pan, to which they give off the last portions of heat. Finally, they pass into the flue of the chimney.

The mixture is spread on the hearth about 3 inches thick, and is not disturbed for about one hour, at which time it is turned over with a rake, and again left for about three-quarters of an hour, after which it is drawn out, and fresh material is introduced, each charge being about 1000 pounds. The decomposition should be complete in the portion withdrawn, and it forms a granular, loose mass of an ash colour. After the mass has thoroughly cooled, it is lixiviated in an ordinary tank, and the dissolved soda and aluminate of soda is drawn off, and the residue is properly washed. The solution will, on an average, mark 26° to 28° Baumé.

The lye, being a strong solution of soda, carbonate of soda, and aluminate of soda, is treated with carbonic acid, in order to produce carbonate of soda and alumina. The carbonic acid is produced by the combustion of coke, and the products of combustion are drawn off by means of a fan, and passed through stacks filled with coke, down which water is made to trickle; and in this way the carbonic acid is washed and purified. The purified gas is passed from these stacks into a large horizontal cylinder, from 40 to 50 feet long, through the middle of which a shaft with paddles rotates. The cylinder is about half filled with liquor, the paddles are put in motion, and the gas is let on through one end of the cylinder, the unabsorbed gases escaping at the other end. When the solution is saturated with carbonic acid, it is run off into settling-boxes capable of holding one charge. In about from four to six hours the alumina will have separated from the liquor which is drawn off, and the deposited alumina is freed from the adhering soda by washing it with water, and filtering upon proper filters. The clear solutions first drawn off has a density of about 31° Baumé, and the alumina is left in the form of a granular powder. In this way two valuable products are produced from the cryolite—carbonate of soda and alumina. The latter contains but a trace of soda, and is a valuable material for the manufacture of alum and sulphate of alumina.

Considering the nature of the mineral and its impurities, sometimes amounting to 10 or 15 per cent, the carbonate of soda is remarkably pure, its only impurity being one or two per cent of sulphate of soda, the sulphuric acid having been formed from the sulphides that are associated with the cryolite.

The Wet Process.—If cryolite be boiled with six equivalents of lime, the decomposition which takes place is similar to what occurs in the dry process; but if two equivalents of cryolite be boiled with fifteen equivalents of lime, the resulting product will be caustic soda, aluminate of lime, and fluoride of calcium.

$$2(Al_2Fl_3+3NaFl)+15CaO=$$
$$=6NaO+2Al_2O_33CaO+12FlCa.$$

In either case the decomposition is effected as follows:—Into a large vertical cylinder, provided with a perpendicular shaft having paddles, and a steam-pipe, ending close to the bottom in a perforated ring, is introduced milk of lime, made from about 15,000 pounds of good lime. The paddles are now put in motion, and the mass is agitated for a little time, and the liquid is then assayed and measured, so as to ascertain the exact amount of lime present. The cryolite is then added in fine powder in the proportion desired to accomplish a given result. Two equivalents of cryolite, and twelve equivalents of lime will produce, as already stated, caustic soda and aluminate of soda. Fifteen equivalents of lime will furnish all the soda as caustic soda, with aluminate of lime. Fluoride of calcium is formed in both cases.

After two or three hours' boiling and agitation, the decomposition is generally completed (testing will indicate the liberation of all the soda), and the contents of the agitator are discharged on a suitable filter. The clean liquor which will form on top of the sediment is drawn off, and the sediment is treated with water as long as the filtered liquid contains soda,

If the first proportion of lime has been used, and aluminate of soda has been formed, the liquid is treated with carbonic acid, as in the dry process, and all the soda is converted into carbonate, and the alumina is deposited as an insoluble residue. If the latter proportion of lime is used, and all the soda be in the solution as caustic soda, all that it is necessary to do is to evaporate the liquid to dryness in pans or kettles. In this manner caustic soda, containing 75 per cent of NaO is manufactured on a very large scale at Natrona.

It is evident that the wet process is decidedly the simpler of the two, there being less handling, and less costly apparatus; but the feeble strength of the lye produced (10° B.) by this process, and consequently the large amount of water to be evaporated, is a great drawback to it. Where alumina is of but little value, and caustic soda is much sought after, the wet process with fifteen equivalents of

lime may be most profitably employed. Where the contrary is the case, the dry process is to be preferred, producing a lye of 26° to 28° B., and requiring but little concentration in order to crystallise.

Besides working out all the details of this process, Julius Thomsen has devised volumetric processes of analysis adapted to different stages of the operation. Weber and Brother, of Copenhagen, not only furnished all the means necessary for conducting his experiments, but established a factory in Copenhagen, and sent vessels to Greenland for the cryolite. Their factory has been the model on which others have been erected.

There are four establishments in Germany, consuming annually about 2000 tons of cryolite; and in 1867 the one in this country was erected by the Pennsylvania Salt Manufacturing Company, having a capacity for working up about 6000 tons of cryolite. This company, in 1867, imported 8000 tons, and sent out to Greenland during the summer nineteen vessels of an average capacity of 450 tons, of which two were lost in the ice. The approach to the coast is considered dangerous on account of the fields of ice, which sometimes form a thick and impenetrable belt of 80 to 100 miles in width. Off the western coast of Greenland the wind scatters the ice, and a good navigator can penetrate the openings without delay. No loss of life has yet occurred in this trade, as the ice affords a refuge for a shipwrecked crew until removed by the Esquimaux, or until they escape by their boats to the settlements. The mines are worked, from May to October, by about one hundred and fifty men. In the salt works of Natrona, Pennsylvania, more than half a million of dollars have been invested, and employment has been given to five hundred men. The alumina manufactured there in connection with the soda is supplied to the largest makers of alum in this country. The various manufactures from cryolite have a market value of over 1,500,000 dollars in gold.

There has been no important improvement on Thomsen's processes, except it be one by G. A. Hagemann, on which a patent has just been obtained.

Bauxite (a mineral containing 80 per cent of alumina) is sometimes mixed with the cryolite to increase the yield of alumina.

Much space has here been devoted to this manufacture of cryolite soda, from the fact that cryolite and its products were conspicuous in the Exposition, and that the value of cryolite and its treatment, as a soda-yielding substance, is but little understood and appreciated by technical chemists generally.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

June 1st, 1871.

Professor FRANKLAND, F.R.S., President, in the Chair.

THE following gentlemen were elected Fellows:—H. Adrien, H. Durham, G. Martineau, E. Neison.

Dr. DEBUS, F.R.S., delivered a lecture on "*Ozone.*"

The lecturer began by stating why ozone is considered to be an allotropic modification of oxygen; then discussing whether there are reasons to assume the existence of two allotropic modifications, and concluded with a review of some of the properties of ozone.

Van Marum, in 1785, seems to have been the first to observe that the passage of electric sparks through oxygen causes this gas to become more energetic in its action on other bodies, and to assume at the same time a peculiar odour. Next Schönbein, in 1840, took this subject up, and instituted a series of experiments on the nature and properties of ozone. He proved that the gas developed at the positive electrode, when a galvanic current is passed through water acidulated with sulphuric acid, possesses the same properties as oxygen which has been subjected to repeated electric discharges, and that the electrolytic oxygen retains those properties when kept over water. He attributed the change undergone by the gas to a peculiar substance to which he gave the name of ozone. It was further found by him that ozone is formed in air, when phosphorus is allowed to oxidise in it. His experiments, however, led to no positive results as regards the nature of ozone; his theory that water and air contained a small quantity of an unknown substance, which in composition was analogous to hydrochloric acid, and which by electricity and other means was decomposed into hydrogen and ozone, was an opinion that could not be supported by facts.

The first experiments establishing the fact that ozone was only an allotropic modification of oxygen were made by Marignac and De la Rive about 1845. Among the more important observations Marignac had made regarding ozone were: That it is best obtained by passing air slowly over phosphorus in a tube 1 metre in length and 6 m.m. in diameter; that it cannot be obtained from dry air, neither from dry and pure oxygen by means of phosphorus; and that ozone contains nothing but oxygen. Schönbein did not accept this conclusion, but asserted (1847) that ozone was a peroxide of hydrogen. His opinion was supported by the experiments of Williamson and Baumert. It appeared, therefore, that there existed two kinds of ozone: the one, obtained by passing electric sparks through oxygen, or by the action of phosphorus on air, being allotropic oxygen; and the other, obtained by the agency of the electric current, being a peroxide of hydrogen.

Against this latter view Andrews maintained that ozone prepared by electrolysis did not differ in its nature from ozone obtained through other methods. He was borne out by Soret, who, in 1863, made some experiments which in many respects were only a repetition of those instituted eighteen years earlier. For drying the gas to be examined, Williamson employed an ordinary chloride of calcium tube. It was not known in 1845 that the last traces of moisture cannot be removed from a gas unless the chloride of calcium tubes are very long.

Thus, according to our present knowledge, ozone is an allotropic modification of oxygen.

The lecturer next proceeded with the consideration whether there was another modification of oxygen, the so-called antozone. This substance is said to be formed either by the action of concentrated sulphuric acid on baric peroxide, or along with ozone when oxygen is submitted to silent electrical discharges, and one of its best characteristics is the property to assume in contact with water a cloudy appearance and to oxidise the water to hydrogen peroxide. But an experiment of Messrs. Nasse and Engler shows that antozone is only peroxide of hydrogen vapour diffused through a very large quantity of air or oxygen.

There exists, therefore, only one allotropic modification of oxygen, viz., ozone.

About the properties of ozone, the lecturer did not think it necessary to say much, as they are so well known, and he directed attention only to one reaction—the decomposition of potassic iodide. This reaction is differently explained by different observers. Schönbein's observation, however (according to which iodine is protected through potassic iodide against the action of potassic hydrate), seems to lead to the best explanation. It may be assumed that on adding potassic hydrate to a solution of iodine these reactions take place:—$KHO \times I_2 = KIO + HI$, and then $KH + OHI = KI + H_2O$. Now, if an excess of potassic iodide be added, the potassic hypo-iodite and the potassic iodide produce again iodine and potassic hydrate, thus:—$KI + OKI = KKO + I_2$, then $KKO + H_2O = 2KHO$, and here the excess of potassic iodide will prevent the potash from attacking the iodide, but allow the latter to act upon starch. From this, now, the action of ozone on a mixture of potassic iodide and starch is easily understood. In the

first place, the potassic iodide being in excess, ozone forms in presence of water potassic hydrate and free iodine. But as by degrees the potassic iodide is decomposed and diminished in quantity, the potash commences to act on the iodine and to form potassic iodate and iodide. The latter is acted upon by the ozone until a certain amount of KHO has accumulated and can with free iodine form iodate and iodide. This process goes on until all the iodide is converted into iodate and the mixture has lost its blue colour.

NOTICES OF BOOKS.

Analytical Tables for Students of Practical Chemistry. By J. CAMPBELL BROWN, D.Sc., Professor of Chemistry and Toxicology at the Liverpool Royal Infirmary School of Medicine, and Lecturer of the Liverpool School of Science. London: J. and A. Churchill. Liverpool: A. Holden. 1871.

THE author has published this work, the first part of a series, at the request of several teachers as well as students. The tables are not intended to supersede *vivâ voce* instruction, but to be used as notes by which to follow and recall to mind the demonstrations of the teacher. The following are the contents of this useful book:—Table for the Analysis of Gases; Preliminary Examination for Simple Salts and Mixtures; Table for the Separation of Metals into Groups; followed by six tables for the Detection of the Separate Groups; General Examination for Mineral Acids; Special Tests for Mineral Acids; Examination of Organic Compounds; Behaviour of Some Neutral Substances whose Presence may be Suspected by their Taste; Table for the Separation of Organic Bases; Characteristic Tests for the Principal Organic Bases. Although these tables are arranged for the examination of complex substances, it is evident that they may be conveniently employed for the detection of simple substances by omitting all those details which refer to the separation of one substance from another.

CORRESPONDENCE.

AGRICULTURE AND CHEMISTRY.

To the Editor of the Chemical News.

SIR,—Permit me to say a few words on two matters of great agricultural importance which have been recently alluded to in the CHEMICAL NEWS. I refer to the scientific education of farmers' sons and to the manure trade.

In the year 1866 I made an experimental trial of the plan lately proposed by Mr. Marshall Hall. I then commenced a series of forty lectures to a class of farmers' sons at Kingscote, a village about 15 miles from the Agricultural College. The lectures were given under the auspices of the well-known Kingscote Agricultural Association, a thriving and enlightened farmers' club. The class, numbering something like twenty, was quiet, regular in attendance, and passed a fair examination at the close of the course, which extended over two years. The lectures were devoted to inorganic, organic, and agricultural chemistry, the subjects being taken in this order, that a good scientific basis for the agricultural application of chemistry might be secured. At the same time an agricultural bias was given, even to the earlier lectures, by illustrative experiments, made, as far as possible, with substances produced on the farm or useful to the farmer, with plants, soils, and manures. More than this, the pupils of my class were encouraged to repeat the chief experiment shown in the lectures, and several of them actually fitted up little laboratories of their own at home. I regret that I have not been able to repeat so encouraging an experiment, but the great difficulty was in the distances which both students and teacher had to travel in order to reach the place of meeting. My own journeys, during this course, give a total length of 1200 miles, and, owing to the absence of a railway, had to be performed under peculiar difficulties. But I am convinced that the system which I carried out in 1866-7, and which Mr. Marshall Hall has just suggested in his letter to the *Devizes Gazette*, may, when suitably modified in accordance with local circumstances, be carried out with immense advantage to the general farming interest. I ought to add that the scheme above described owed much to the suggestion and help of the Principal of the Agricultural College. I hope, on another occasion, to develope further, a method of scientific instruction for young farmers, and to describe a plan for the creation in England of agricultural experimental stations where chemistry might be brought to bear upon agriculture in several directions.

I would now ask for a little more space, in order to describe briefly one of the most obvious aspects of the manure question. How is it that manufactured manures, such as the different varieties of superphosphate of lime, are often sold to farmers at a price *so much higher* than that at which their crude constituents can be purchased? We know that the process of manufacture is not tedious or troublesome, and that its cost is small. And we know also that many manufacturers of superphosphate supply manure-dealers wholesale with fair qualities of this manure on terms which allow the latter a broad margin of profit, but that the farmer has to pay not the manufacturer's charges only, but those of the dealer as well. Mr. Little has pointed out* one of the ways in which a farmer may get a manure for, say, £4 per ton, which shall be guaranteed to contain 26 per cent of "soluble phosphate," and for which he would have to pay, in the ordinary course, from 5 to 6 guineas, if not more. But it is only fair to point out that two manures may analyse equally well and yet differ in their effectiveness very considerably. This remark applies with especial force to nitrogenous manures in which the nitrogen may exist in various degrees of availability. It is, on the other hand, highly probable that the soluble part of a mineral superphosphate, provided some decomposing carbonaceous matter be present, is as useful as the corresponding constituent of a bone superphosphate. Thus the argument for difference of price which manufacturers urge by reason of their employment of the best materials must not be pushed too far. An instance in point may serve to illustrate my meaning clearly.

In the spring of this year some samples of manure were sent to me for examination. I was subsequently informed that the price charged for them was £8 8s. per ton. Now, on analysis, I could only rate them at about £5 5s. per ton, assuming their several manurial elements to have been derived from the most valuable crude materials. But what was the argument against my valuation which Messrs. A and Co., the well-known manufacturers of this manure, urged with the farmer who had purchased the manure? It was to the following effect:—"Our manures are the final result of long-continued thought and experiment; they have been successfully submitted in the field to the severest trials by numerous farmers; we have sunk thousands of pounds in arriving at our present processes of manufacture, &c., and, moreover, our manures are compounded and mixed in such admirable proportions, and with such exquisite skill, that they must not be judged of by the inadequate test of chemical analysis." Let us pursue this admirable argument a step farther: let us apply it to an animal's food instead of a plant's food. Only mix stones with bread, with a sufficient amount of exquisite skill, and anxious thought, and long experience, and the innutritious stone or other rubbish becomes a most useful material for sustaining life!

Unfortunately, the farmer has not only to deal with mixed manures (which too often justly deserve the epithet "nostrum" which Mr. Little uses in this connection), but

* CHEMICAL NEWS, vol. xxiii., p. 248.

he has to suffer from the gross frauds of purposed adulterations. We shall not easily forget the revelations as to the ochre-grinding machine at a Liverpool guano-works, nor the *exposés* which are continually made in our agricultural journals. But most manures *are* tempting subjects for adulteration. After all they won't crystallise and won't distil, and so come under the great class of "dirts." Here is an analysis of a very dirty dirt indeed, which was analysed in my laboratory last week, having been purchased for a good superphosphate, at a good price, by a deluded agriculturist.

Analysis of Superphosphate; from Mr. ——, *May* 24, 1871.

Water	17·33 per cent.
*Organic matter and combined water	16·31 ,,
†Monocalcic phosphate	1·74 ,,
Tricalcic phosphate	5·02 ,,
Calcium sulphate	12·92 ,,
Common salt	16·82 ,,
Sand	19·00 ,,
Alumina, ferric oxide, and alkaline salts.	10·86 ,,
	100·00

It is evident than in making this exquisite mixture the zeal of the operator had outrun his discretion: he had, evidently, scraped the floor a trifle *too* hard.—I am, &c.,

A. H. Church.

Royal Agricultural College, Cirencester.

MISCELLANEOUS.

Marlborough College.—The Head Master of Marlborough College having determined to introduce natural science as part of the school work, Mr. G. Farrer Rodwell has just been elected science master, and therefore resigns his present appointment at Clifton College, Bristol. Mr. Rodwell enters upon his new duties at the commencement of Michaelmas term.

The Educational Lectures delivered at the London Institution during the past session, by Professor Huxley, Dr. Odling, and Mr. R. A. Proctor, were followed by examinations, and on Wednesday last the prizes and certificates obtained by the students were distributed by Thomas Baring, M.P., F.R.S., the President of the Institution. In Chemistry, the first prize was awarded to Frederick Garrett, and the second prize to A. J. Richardson. In Biology, Miss Dora Harris gained the first prize, while A. Percy Lloyd and Miss F. L. Tolmé obtained second prizes. In Astronomy, the first prize was gained by A. J. Wallis, and second prizes fell to Miss Annie Piper and Edward Garrett.

British Association for the Advancement of Science.—The next meeting of this Association is to be held at Edinburgh, and will commence on Wednesday, the 2nd of August, under the Presidency of Sir William Thomson, M.A., LL.D., D.C.L., F.R.S., &c. The facilities now afforded by the several Railway and Steam-Boat Companies to parties travelling from all parts of Great Britain and the Continent, render it probable that this meeting will be very numerously attended. The local authorities and the representatives of the various scientific societies, as well as all those officially connected with the association, earnestly desire that the members and Associates should receive a cordial welcome, and that everything possible should de done to make the visit agreeable and instructive.

British Association of Gas Managers.—The Eighth Annual General Meeting of the members of this Association will be held on Tuesday, Wednesday, and Thursday, the 13th, 14th, and 15th of June, 1871, at the Royal Dublin Society's Rooms, Kildare Street, Dublin. Edward White, Esq., Vice-President, will occupy the chair. *Order of Proceedings.*—Tuesday, at eleven o'clock, Inaugural Address by the Vice-President, and Reading of Papers and Communications; at seven p.m., Lecture by Dr. Letheby on "The Analysis of Gas." Wednesday, at eleven a.m., Reading of Papers and Communications, Election of Officers for ensuing Year, &c.; at six p.m., the Members and Friends will dine together at the Ancient Concert Rooms, Dublin. Thursday, Excursion to Glendalough, to visit the Lead and Silver Mines, and other places of interest in the neighbourhood. *List of Papers and Communications to be submitted to the Meeting.*—Report of the Committee on the establishment of a Benevolent Fund and the Reduction of Sunday Labour. "Lithology of Gas Coals," by Mr. Jas. Paterson, Warrington; "On the Best Form of Condenser," by Mr. W. J. Warner, South Shields; "On a New Equilibrium Gas-Governor," by Mr. Chas. Hunt, London; "On the Economy of Employing Exhausters," by Mr. Geo. Anderson, London; "On the Apparatus for and Method of Manufacturing Sulphate of Ammonia, suitable for small Works," by Mr. Jas. Eldridge, Richmond; "On the Cause and Prevention of Choked Ascension-Pipes," by Mr. John Somerville; "Carbonising Accounts," by Mr. W. J. Warner, South Shields; "Carbonising Accounts," by Mr. John Niven, Clayton; "Coal Storeage and Spontaneous Combustion of Coals," by Mr. A. H. Wood, Hastings; "Spontaneous Combustion in Coal-Stores," by Mr. A. C. Fraser, Middlesborough; "On Gas Measurement," by Mr. F. W. Hartley, London; "On the Manufacture of Gas from Coal-Tar," by Mr. J. Arnott, Leeds; "Additional Experience of Tar Pavement," by Mr. G. Anderson, London.

* Containing nitrogen equal to 0·372 per cent ammonia.
† Corresponding to 2·31 per cent bone earth made soluble.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 8, 1871.

From the protocol of the meeting of this Society held on the 8th of May last, we learn that it is intended to submit to the approval of an extraordinary meeting of the members a proposal of the Council concerning the publishing in separate numbers of a large number of memoirs sent into the Society, the extent and length of which essays prevents them being published along with the *Berichte*. This number contains the following original memoirs and papers:—

Derivatives of Phosphuretted Hydrogen which Correspond to Ethylamine and Diethylamine.—Dr. A. Hofmann.—The eminent author describes, in this exhaustive essay, another series of researches belonging to those mentioned in former papers on this subject, and treats, in this instance, on—Monoethyl-phosphine—

$$C_2H_7P = \left\{ \begin{matrix} C_2H_5 \\ H \\ H \end{matrix} \right\} P,$$

a very mobile liquid, colourless, insoluble in water, highly refractive specifically lighter than water, boiling at 25°, very strong odour, bitter taste, very readily oxidisable, bleaching cork as chlorine does, acting strongly upon caoutchouc, which becomes transparent and loses its elasticity. When brought into contact with chlorine, bromine, or fuming nitric acid, ethyl-phosphine takes fire; it combines with sulphur and sulphide of carbon, forming liquid compounds therewith; combines, likewise, with concentrated hydrochloric, hydrobromic, and hydriodic acids, forming salts, the first-named of which forms a double salt with chloride of platinum, which, in its outward appearance, is quite as beautiful as crystallised chromic acid. Diethyl-phosphine,

$$C_4H_{11}P = \left\{ \begin{matrix} C_2H_5 \\ C_2H_5 \\ H \end{matrix} \right\} P$$

also a highly refractive liquid, insoluble in water, boils at 85°, absorbs oxygen with such rapidity as to cause, occasionally, the spontaneous ignition of this liquid. In most of its more prominent properties, this compound corresponds to that just alluded to. The author calls attention to the parallelism of the ammonia and phosphuretted hydrogen derivatives in the following manner:—

Ammonium iodide.		Phosphonium iodide.
H_4NI		H_4PI.
$(C_2H_5)H_3NI$	Primary substitution	$(C_2H_5)H_3PI$.
$(C_2H_5)_2H_2NI$	Secondary substitution	$(C_2H_5)_2H_2PI$.
$(C_2H_5)_3HNI$	Tertiary substitution	$(C_2H_5)_3HPI$.
$(C_2H_5)_4NI$	Quaternary substitution	$(C_2H_5)_4PI$.

Action of Pentachloride of Phosphorus upon Chloral-Ethyl-Alcoholate.—Dr. L. Henry.—The contents of this paper are a rep'y to a series of observations made by M. O. Jacobsen on the author's investigations on the action of the pentachloride of phosphorus upon the chloral-alcoholate, the product being $CCl_3---CHCl---C_2H_5O$, or the thrice chlorinated chlorethyl-oxyethyliden. This body is, as regards its composition, a four times chlorinated ethyl-ether. It appears that M. Jacobsen, having made a series of experiments on the substitution products of ether, has found a tetrachlor-ether of a different nature; and the greater portion of this paper is devoted to the explanation of some views held by the last-named author, and refuted as untenable by the author named at the heading of this paper.

Contribution to the History of Naphthazarine.—MM. A. A. de Aguiar and A. G. Baeyer.—This paper is a continuation of a former paper on this subject, and contains the following sections:—Trioxy-naphtho-chinon from dinitro-naphthaline, $C_{10}H_3(HO)_3O_2$; trioxy-naphtho-chinon from naphthazarine; mixture of tri- and tetra-oxy-naphtho-chinon, $C_{10}H_3(HO)_3O_2$, $C_{10}H_2(HO)_4O_2$.

Fatty Oil from Grape Pips.—A. Fitz.—The pips contained in grapes contain from 15 to 18 per cent of an oil, which has been the subject of a series of researches made by the author, and recorded in this essay. The oil, having been saponified, was found to contain palmitic, stearic, and erucic acids, the latter fusing at 34°; formula, $C_{22}H_{42}O_2$. The lead-salt of this acid is difficultly soluble in ether in the cold, but readily so in warm ether; the same obtains with alcohol. The erucic acid exceeds in quantity the two other acids just named, the three being, in the neutral oil, combined with glycerine. When fused with caustic alkali, erucic acid is converted into arachnic acid, $C_{20}H_{40}O_2$, and into acetic acid. The author states that the oil alluded to might be used for culinary purposes; of course it is only obtainable in quantity in wine-growing countries.

New Mode of Formation of Trithionic Acid.—Dr. F. Muck.—The contents of this paper, however interesting in a scientific point of view, do not admit of any useful abstraction, owing to the necessity of reproducing a lengthy series of formulæ.

Some Alloys.—Dr. A. Bauer.—The alloy of platinum and lead, composed, as described by the author in a former paper on this subject, according to the formula PtPb, may be obtained in larger quantities, and free from finely-divided platinum being mixed with it, by fusing in a crucible the platinum, to which a slight excess of lead has been added under a cover of borax glass (previously fused and pulverised borax). The combination of the two metals is attended with a considerable evolution of heat and light. The crucible should be allowed to cool very slowly by being placed in hot ashes, and is, after cooling, broken up, when the alloy is obtained in the shape of a crystalline bismuth-coloured mass, and readily freed from the small excess of lead it contains by being treated with acetic acid. The calculated density of this alloy is 14·89, proving that a contraction takes place when this alloy is formed. *Amalgam of Lead and Mercury.*—Two parts, by weight, of lead are fused, and to the molten metal 1 part, by weight, of mercury added, and the two metals thoroughly mixed; and this mixture, after cooling, treated with acetic acid until no more white-lead and acetate of lead were formed. The unaltered portion of the amalgam, having been carefully analysed, was found to consist, in 100 parts, of—Lead, 40·82; mercury, 59·17; corresponding to the formula Pb_4Hg_3. Sp. gr. of this amalgam, 12·6085. *Lead and Palladium.*—One part, by weight, of each metal was fused together in a crucible, and the alloy afterwards treated with acetic acid as above alluded to for other alloys. The residuary alloy, having been analysed, was found to consist, in 100 parts, of—Palladium, 60·79; lead, 32·20. Formula, Pd_3Pb; sp. gr., 11·25. This alloy is difficultly fusible, and is not capable of occluding hydrogen. *Lead and Gold and Lead and Silver.*—1·5 parts of gold and 11 parts of lead, on the one hand, and 10 parts of silver and 7 parts of lead were fused together. The alloys were, in each case, rolled out to thin sheets, and then treated with acetic acid; but after the removal of the last traces of white-lead, which was formed by the aid of very dilute acid, it was found that the remaining metals were nearly perfectly pure gold and silver, and no alloy of these metals and lead was, under any conditions, obtainable. *Zinc and Copper.*—The author relates that, some thirty years ago, a sample of beautifully-crystallised brass was sent to the Vienna Mint for investigation, since that alloy had been accidentally formed at some brass foundry. The analysis then made by Dr. F. Hoffmann proved this sample to consist, in 100 parts, of—Copper, 74·513; zinc, 25·487; leading to the formula Cu_2Zn. The author observes that, many years ago, Dr. Croockewit published an exhaustive monograph on the subject of metallic alloys, an abstract of which was published in the *Annalen der Chemie und Pharmacie*, vol. lxviii., p. 290.

Analysis of some Minerals met with in the neighbourhood of the Native Warm Baths of Teplitz.—Dr. J. Stingl.—Quartzose porphyry (sp. gr., 2·567) contains, in 100 parts—Silica, 75·74; alumina, 15·07; peroxide of iron, 3·86; magnesia, 0·63; lime, 0·95; potassa, 1·85; soda, 0·51; water, 1·43. Ochry deposit from a source of mineral water, the Neubad, at Schönau, near Teplitz, Bohemia (sp. gr., 2·73), contains, in 100 parts—Peroxide of iron, 2·24; protoxide of manganese, 5·34; lime, 43·77; carbonic acid, 34·84; water, 3·11. This portion, 88·96 per cent of the whole, is soluble in hydrochloric acid; the rest, 11·04 per cent, insoluble therein, consists of—Silica, 9·44; alumina, 1·06; peroxide of iron, 0·42; lime and alkalies, traces. Another similar ochry deposit, but from a different locality, was found to contain, in 100 parts—Matter soluble in hydrochloric acid, 29·86; insoluble therein, 70·14. Analysis of a kind of travertine deposited from a hot spring (sp. gr., 2·698) contains, in 100 parts—Silica, 0·16; carbonic acid, 41·50; lime, 52·50; peroxide of iron, 2·49; alumina, 0·25; soda, 1·75; water, 1·29; and traces of lithia and magnesia.

On Gallein.—Dr. A. Baeyer.—The author describes the mode of preparation, by means of fusing together, at a temperature of 200°, kept up for some hours, a mixture consisting of 1 part of anhydride of phthalic acid with 2 parts of pyrogallic acid. The cooled mass is treated with hot alcohol, filtered, and diluted with water, whereby a precipitate is obtained of the substance just named (gallein), which, as far as the author's researches go, appears to be a new addition to the already large number of artificially-obtainable dyes. It is a brownish-red coloured body, in large lumps exhibiting a greenish yellow metallic hue; insoluble in cold water; difficultly soluble in boiling water, the solution being red-coloured; readily soluble in alcohol—colour of solution, deep red; soluble in aqueous caustic potassa solution, colour beautifully blue; ammoniacal solution, violet-coloured. It appears that gallein has a great similarity to hæmatein; and the author states that the former substance is, therefore, the first artificially obtained belonging to the group of the peculiar constituents of logwood and similar dye-stuffs. Not only phthalic acid, but trimesic, pyromellitic, and prehnitic acids, and oil of bitter almonds, yield, when fused, as above stated, with pyrogallic acid, gallein.

Researches on the Constitution of the Benzol Derivatives.—Dr. V. von Richter.—This lengthy memoir contains the following sections:—On dibrombenzol; a new synthesis of acids by the action of cyanide of potassium on some nitro-compounds, according to the formula—

$$C_6H_4\left\{\begin{matrix}Br\\NO_2\end{matrix}\right\}+CNK=C_6H_4\left\{\begin{matrix}Br\\CN\end{matrix}\right\}+KNO_2;$$

isomeric nitrobenzols; conversion of brom-nitrobenzols into brom-benzoic acids; isomeric chloro-nitrobenzols; conversion of chloro-nitrobenzols into chlorobenzoic acids; meta-brombenzoic acid; on the constitution of nitrous ether.

Researches on Valeraldehyde.—Dr. A. Schröder.—This paper treats on:—*Valeraldin.*—Obtained by causing a current of dry ammoniacal gas to be passed over sulpho-valeraldehyde—

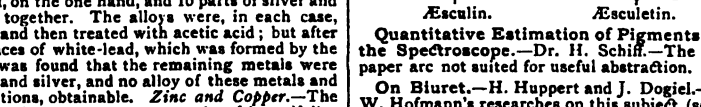
$$3C_5H_{10}S+2NH_3=C_{15}H_{31}NS_2+NH_4HS.$$

Valeraldin fuses at 41°; its vapour density is 144·50; it is a somewhat indifferent body, insoluble in water, and soluble in alcohol and ether. *Carbo-valeraldin.*—Formed by the reaction of excess of liquid ammonia upon a mixture of sulphide of carbon and valeraldehyde, according to the following formula:—

$$2C_5H_{10}O+2NH_3+CS_2=C_{11}H_{23}N_2S_2+2H_2O.$$

Carbo-valeraldin, $C_{11}H_{23}N_2S_2$, is insoluble in water, soluble in cold alcohol and ether, crystallises from its solution in the last-named body, fuses at 115° in a vacuum, but is dissociated, when heated in contact with air, at between 100° and 160°; vapour density, 60·08. The last portion of this paper treats on the constitution of valeraldehyd-ammonium by the precise determination of its sp. gr. in the state of vapour. The anhydrous valeraldehyd-ammonium, $C_5H_9(NH_4)O$, has at 160° a vapour density of 52·16, as found by experiment: calculation gives 51·5; therefore the vapour density of valeraldehyd-ammonium is normal.

Constitution of Æsculin.—Dr. H. Schiff.—Considering that æsculin, $C_{15}H_{16}O_9$, is converted, by the action of acetanhydride, into hexacetyl-æsculin, $C_{15}H_{10}(C_2H_3O)_6O_9$, and, by the action of aniline, into trianil-æsculetin, $C_{18}H_{16}O_8(C_6H_5N)_2$, the author therefore decides that the constitutional formulæ of æsculin, æsculetin, and para-æsculetin should be as follows:—



Æsculin. Æsculetin. Para-æsculetin.

Quantitative Estimation of Pigments and Dyes by means of the Spectroscope.—Dr. H. Schiff.—The contents of this valuable paper are not suited for useful abstraction.

On Biuret.—H. Huppert and J. Dogiel.—After referring to Dr. A. W. Hofmann's researches on this subject (see CHEMICAL NEWS, vol. xxiii., p. 227), the authors state that they have succeeded in converting allophanic ether into biuret by fusing that ether in an atmosphere of ammonia gas; but the quantity of biuret obtained is, in the first place, very small, and the product is impure, while, moreover, a large portion of the allophanic ether is volatilised before the reaction, which requires a temperature higher than the point of sublimation, 115°, of the ether, sets in. The reaction, therefore, here alluded to is only of scientific interest, taken in connection with Dr. Hofmann's researches.

Journal für Praktische Chemie, No. 6, 1871

This number contains the following original memoirs and papers:—

Action of Chloride of Sulphur upon Aniline in the Presence of Sulphide of Carbon.—A. Claus and W. Krall.—The contents of

this very lengthy essay, commenced in No. 5 of this periodical, and recording an exhaustive series of experiments, may be summarised as follows:—By the action of chloride of sulphur upon aniline, the sulphide of carbon does not act as an indifferent solvent, but is an active ingredient; since, in the first place, 4 molecules of aniline, 2 of chloride of sulphur, and 1 of sulphide of carbon react upon each other according to the following formula:—

$$4(C_6H_7N)+2SCl+CS_2=S+2(C_6H_7N.HCl)+C_{13}H_{12}N_2S.$$

If more chloride of sulphur is used than agrees with the formula just quoted, that substance then causes the decomposition of the sulphocarbanilide; but the sulphide of carbon does not, in this instance, come into active play, and the reaction takes place according to the formula—

$$2(C_{13}H_{12}N_2S)+2SCl=C_7H_4NS+C_{19}H_{17}N_3HCl+HCl+3S.$$

Formation of Transparent Cubes of Chloride of Sodium similar to Rock-Salt.—Dr. L. A. Buchner.—This paper is, in a measure, the reproduction of the contents of an essay published by Dr. Mohr (*Poggendorff's Annalen*, vol. cxxxv., p. 667, 1868), "On the Formation of Rock-Salt." The author relates, in confirmation of the facts adduced by Dr. Mohr, a few instances which prove that the formation of cubes of rock-salt, and of other chlorides isomorphous therewith, actually takes place slowly by the spontaneous evaporation of concentrated brines and the gradual diffusion of the thus supersaturated solution downwards (in the vessel wherein that solution is contained), so that the cubes form, and increase gradually in size, at the bottom of the vessel which contains the saline liquor. The author also observed, in one instance, the formation of chloride of ammonium in cubical crystals deposited from the so-called Kœchlin's copper liquor (*Liquor cupri ammoniato-muriatici*), the evaporation having been caused by the not well fitting of the stopper; but this process had taken years to produce the cubical form of crystals of sal-ammoniac alluded to.

Structural Formulæ.—Dr. A. Claus.—A critical review on Professor Kolbe's lengthy esssay on this subject, lately published in this periodical.

Researches on Hydrated Oxide of Iron.—Dr. E. Brescius.—After referring to the various formulæ given by a large number of authors to the hydrates of oxide of iron, the author records a series of experiments made with the view to ascertain the true composition of the hydrated oxides alluded to. It appears that, neither when dried over sulphuric acid, nor, also, when dried at 100°, until in each case no change of weight took place, did it possess the composition corresponding to the formulæ Fe_2O_3HO, Fe_2O_32HO, and Fe_2O_33HO, which are quoted by various authors. The hydrates of the oxide of iron are, further, very hygroscopic, and, in addition thereto, may retain water mechanically. The author also found that the most stable hydrate he could obtain, Fe_2O_32HO, loses a portion of its water at 100°, and another portion only at a red heat. The composition of the hydrate which had been kept for fifteen months under water is not that which agrees with the formula given to it by Dr. Wittstein, $2Fe_2O_33HO$. The author is engaged with further experiments on this subject.

Dissociation Phenomena Exhibited by Aqueous Solutions of Chloride of Iron.—Dr. F. W. Krecke.—The first, and as yet incomplete, portion of an essay on this subject.

Moniteur Scientifique, May 1 and 15, Nos. 345 and 346 (double number), 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Memoir on the History of the Discovery of Genuine (Véritable) Artificial Alizarine.—P. Alfraise.—This very lengthy and exhaustive memoir is divided into the following chapters:—Origin of our researches of this discovery (viz., of artificially-prepared alizarine); history of the scientific labours from the time (1826) of the discovery of alizarine in madder (by MM. Robiquet and Colin, at Paris) up to the time of the synthetical preparation of alizarine; history of the more important pseudo-alizarines discovered before the genuine artificially-prepared alizarine was found. The author comes to the conclusion that the material obtained from anthracen is not at all identical with the alizarine obtained from and present in madder; and his reason for this conclusion is, that when alizarine from madder is oxidised with nitric acid, only phthalic acid is produced, not accompanied by any trace of bitter-tasted nitrated body of the phenic series, while alizapurine (the author prefers so to designate, or, also, call anthrazarine, the substance obtained from anthracen), oxidised in the same manner, yields always a large quantity of a bitter-tasted nitrated acid, only accompanied by a faint trace of phthalic acid. Lastly, the author states that he will shortly publish, in a subsequent number of this periodical, the mode of preparation of an artificially-obtainable alizarine, which is really identical with that of madder.

Although not belonging directly to the domain of physico-chemical science, we quote here the titles of the two following very interesting and valuable memoirs:—

Critical Observations on the Use of Words Derived from the Greek Language in Scientific Nomenclature.—Dr. Egger.

Observations on Words Derived from the Arabic Tongue.—Dr. L. A. Sédillot.—This memoir also contains a brief, but valuable, review of the influence exercised by the Saracens in Southern France, and other portions of Southern Europe, on civilisation and the diffusion scientific as well as industrial knowledge.

Zeitschrift für Chemie von Beilstein, No. 5, 1871.

This number contains the following original papers and memoirs:—

Isomeric Toluylen Diamines.—Drs. F. Beilstein and A. Kuhlberg.—This paper treats on the following substances:—Para-meta-toluylen-diamine, $pmC_7H_6(NH_2)_2$.—This body, fusing at 99° and boiling at 280°, has been fully investigated and described by Dr. A. Hofmann (*Jahres. f. Chem.*, 1861, 512); the sulphate of this base, $C_7H_6(NH_2)_2.H_2SO_4+2H_2O$, is soluble in water, precipitated from its solution in that fluid by alcohol, and crystalline. Para-ortho-toluylen-diamine, $poC_7H_6(NH_2)_2$, is a solid body, fusing at 88·5, boiling at 265°, and readily soluble in cold and hot water; but these solutions are spontaneously decomposed by exposure to air. The sulphate of this base, $C_7H_6(NH_2)_2.H_2SO_4+1\frac{1}{2}H_2O$. Meta-ortho-toluylen-diamine. $moC_7H_6(NH_2)_2$, a solid body, colourless, crystalline, fuses at 80°, boils at 270°, and is very prone to spontaneous decomposition. The sulphate of this base, $C_7H_6(NH_2)_2.H_2SO_4$, is anhydrous, difficultly soluble in cold, but somewhat more readily in hot, water; this solution is precipitated by alcohol.

Some Derivatives of Meta-Toluidine.—E. Wroblevsky.—The author describes a series of compounds obtained by causing various reagents to act upon pure meta-acettoluid, viz.:—Brom-acettoluid, $C_7H_6Br(NH.C_2H_3O)$, a beautifully crystalline body, fusing at 156°, and readily soluble in alcohol and boiling water. Brom-toluidine, $C_7H_6Br.NH_2$, fuses at 57°, boils (but is, also, then completely dissociated) at 240°, soluble in alcohol, but in water very difficultly; this base yields crystalline well-defined salts with hydrochloric, sulphuric, and nitric acids. *o-m*-dibrom-toluol, $C_7H_6BroBrm$, is fluid, even at −20°, and boils at 287°. Dibrom-*m*-toluidine, $C_7H_5BroBr_2(NH_2)m$, a crystalline substance, soluble in alcohol, fuses at 50°, and does not combine with acids. *o*-brom-*m*-kressol, $C_7H_6Bro(HO)m$, also a solid body, crystallises in golden yellow-coloured needle-shaped crystals, very difficultly soluble in water, as well as in alcohol, and fuses at 88·5°.

Chemistry of the Superphosphates.—Dr. K. Birnbaum.—This very lengthy paper is the first instalment of a monograph, the chief aim of which is to investigate thoroughly all the causes of the origin of the so-called reduced phosphates in superphosphates. This portion of the memoir contains a very detailed account of the result of the author's researches on the mono-calcium phosphate, its properties, behaviour towards reagents at a higher temperature, and on the di-calcium phosphate.

NOTES AND QUERIES.

Carbolic Acid.—Some information as to the finishing of carbolic acid, or phenic alcohol, into the pure crystals, would be most acceptable to me. I am now making, for another person, about 2 to gallons of crude carbolic acid per week, but, as there is no demand for it, I have a chance to work it up.—W. G. HOLDING.

Nitrobenzol.—(Reply to "Mitbane.") -You will find every information on the subject in the work "On Aniline and its Derivatives," by M. Reimann, Ph.D., &c., revised and edited by W. Crookes, F.R.S., &c. (London: Longmans and Co.), page 6 and following. On the small scale, you can distil nitrobenzol in a glass retort placed in an oil-bath and provided with a Liebig's condenser.

MEETINGS FOR THE WEEK.

MONDAY, 12th.—Royal Geographical, 8.30.
TUESDAY, 13th.—Photographic, 8.
—— Ethnological, 8.
THURSDAY, 15th.—Chemical, 8. Sir B. C. Brodie, "An Experimental Enquiry as to the Action of Electricity upon Oxygen."
—— Royal, 8.30.
FRIDAY, 16th.—Royal Institution, 9. William Bradford, Esq., Artist, of New York, "On the Esquimaux and Ice of Greenland."

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THE CHEMICAL NEWS.

VOL. XXIII. No. 603.

ON THE

ABSORPTION OF SULPHUR BY GOLD, AND ITS EFFECTS IN RETARDING AMALGAMATION.*

By W. SKEY,
Analyst to the Geological Survey of New Zealand.

A PART of the duty assigned to me while recently on the Thames gold-field, was to investigate into the causes of the loss of gold experienced by the proprietors of the several batteries in that district, when working the auriferous material.

From an acquaintance with the various mechanical arrangements adopted there for securing the gold, and from a knowledge of the nature and amount of such loss, I was soon led to infer that much of it could scarcely be referred to any of the causes severally supposed to be operative.

The affinity of gold and its richer alloys for mercury is so great, and their negativeness or unaffectibility to and by the various chemical substances naturally having contact with them so universally and so authoritatively affirmed, that it is generally supposed all we have to do in order to obtain an amalgam of gold and mercury is to present them to each other, with their surfaces free from dust or stain, and to all appearance chemically clean.

But, in experimenting upon a few samples of the Thames gold, I found that though apparently quite free from any such stains, &c., they would not uniformly amalgamate over their entire surfaces; some, indeed, would not amalgamate in the least, though to all appearance bright, clean, and chemically similar to those which did; the action of boiling water upon these did not in the least affect their negativeness to the mercury. This could not, therefore, be owing to the intervention of air mechanically adherent to them.

Observations taken since my return show, besides, that several of the cleanest-looking samples of the Otago gold which have been deposited in the Colonial Museum, manifest a similar negativeness to mercury—even to whole samples of fine alluvial gold, and those surfaces of small nuggets so situated that it was impossible they could have been hand-soiled.

All these specimens were rendered readily amalgamable by cold solutions of cyanide of potassium, nitric acid, chromic acid, or chloride of lime acidified, and, with the exception of the more cupreous of these, they were also rendered amalgamable by roasting them in an open fire for a few minutes.

Obviously, therefore, some foreign substance occupied these non-amalgamable surfaces, excluding the mercury from contact with the auriferous alloy, which substance was disipated or decomposed by heat, and capable of removal by the several reagents specified; the question then arose, What could this substance be? and I began to suspect that sulphur, in some form or other, was this substance, since its deportment under these conditions would certainly be very similar.

I therefore well cleaned the surfaces of several samples of Thames and Otago gold, and one of pure gold, and placed them for a few seconds in sulphuretted hydrogen gas, well washed them afterwards, and dipped them into clean mercury, when, in the place of being instantly whitened over their whole surfaces by the mercury, they absolutely refused to amalgamate with it upon any part, and even seemed to exercise a repulsive force upon it.†

The same effects, or rather *non-effects*, in relation to the mercury, followed when alkaline sulphides were substituted for the sulphuretted hydrogen, also when the samples of gold were kept a short time in boiling water, in contact with sulphur—a platinum crucible being used as a precautionary measure against the introduction of alkaline matters. As in the case of the first series of specimens, these were rendered amalgamable by treatment with cyanide of potassium, nitric acid, chromic acid, or chloride of lime, also by the application of heat to the less cupreous ones.* The effects of heat on those samples containing 6 per cent of copper (and perhaps much less) being to produce such a film of the oxide upon their surfaces that the mercury is still excluded from them, though from a different cause from that above mentioned. These samples also readily amalgamated with sodium amalgam.

Gold thus treated with sulphuretted hydrogen, sulphur, or alkaline sulphides, and thoroughly washed, then put in pure cyanide of potassium, gave a good reaction of sulphur to the nitro-prusside test; and I have also obtained in the same manner, very distinct reactions of sulphur upon several of the native gold samples in the Museum.

These results clearly show that gold, even when in its purest state, is by no means so negative to sulphur and its compounds as is supposed, but that, on the other hand, it absorbs sulphur with great avidity; and they further show, that when this sulphur is absorbed by gold, even when only in very minute quantity, the metal refuses to amalgamate, although there is no visible change induced in its appearance.

Taken in connection with the presence of sulphur (or a compound of it) upon many samples of native gold, and the certainty that one or other of the sulphurising agents specified does frequently occur naturally in metalliferous rocks, it seems highly probable that a large area of the natural surfaces of native gold is sulphurised, and thus rendered, according to the degree of this, non-amalgamable.

If this is so, a very sufficient cause appears for the heavy loss in the precious metal experienced by the mill-owners in working their auriferous reefs by the amalgamation process, since it would only be those portions or grains thus sulphurised, which have chanced to get their surfaces abraded during their extraction or milling, that would be at all likely to adhere to the mercury used.

Whether this absorption is a purely mechanical one, as is assumed when platinum acts upon sulphuretted hydrogen and other gases, or whether it is a truly chemical one, is a matter of some interest to enquire into, particularly in connection with the, as yet, unsolved problem relative to the mode of solution and deposit of native gold; also, in relation to the question of absorption generally.

By what can properly be deduced from the facts above stated, and those which have manifested themselves to an investigation carried on especially to determine this point, it certainly appears that this absorption is the effect of chemical action.

Thus, if this absorption is mechanical, the sulphur must be in one of the two following conditions:—

I. As free sulphur.

II. Combined with hydrogen, as sulphuretted hydrogen.

(1). That it is not as free sulphur was evidenced by the fact that boiling ether or bisulphide of carbon—two liquids having considerable affinities for sulphur—would not remove it from the gold; for, after long contact with these solvents, and an after thorough washing, the gold still refused to amalgamate.

Neither of these liquids had any effect upon clean gold in regard to its behaviour with mercury.

(2). That it is not combined with hydrogen, and thus condensed on the gold surface as sulphuretted hydrogen, appeared from the circumstance that sulphurous acid effected no apparent change on it; the action of this acid

* Read before the Wellington Philosophical Society.

† This was illustrated at the close of the meeting.

* The chlorides of gold and mercury, also nitrate of silver, have been found lately to have the same effect. See paper "On the Reduction of various Metals from their Solutions by Metallic Sulphides, &c," C. N., vol. xxiii., p. 32).

on sulphuretted hydrogen being a rapidly decomposing one, sulphur being liberated in a free state, capable of being detected and identified as in this state, which I could not accomplish.

Not appearing to be in either of these forms, therefore we must assume it to exist in chemical union with the metal as a sulphide of gold, forming a film of true auriferous pyrites, as was first suggested to me by Dr. Hector.

Independent of the proof derived from experiment, it may be expected that sulphur brought into close contact with a metal which we know does form chemical union with it in a wet way, and at common temperatures, would then be in an extremely favourable condition for the exercise of chemical affinities; and the same argument applies for absorption being generally chemical, wherever there are affinities existing at the temperatures we employ between the absorbants and the absorbed substances.

Indeed, so far these experiments and these arguments are deemed conclusive in favour of the absorption of sulphur by gold being chemical, by so much are we compelled to diverge from the received opinion that the absorption of the common gases by platinum is always a mechanical one, and are compelled to distinguish varieties of absorption.

The affinities of sulphur, also oxygen, for platinum, are superior to their affinity for gold; why not therefore suppose sub-sulphides, or sub-oxides, to form, when these substances are respectively absorbed; but the whole question of these minute actions of metallic surfaces requires rigorous investigation, and for this I doubt not the mercury test here used for proving absolute cleanliness of surface will often prove very useful.

Reverting to that which more strictly falls within the scope of this paper, as sulphur has been found upon native gold, I should be quite prepared to find the metals tellurium and selenium also upon the natural surfaces of the gold of Transylvania and the Thames (these substances being isomorphous with sulphur and more fixed), as telluric gold is found in Transylvania, and the character of the two golds assimilates.

In conclusion, I would beg to observe the necessity of fully establishing the character of this absorption of sulphur by gold. If it is a chemical act, as present evidence tends to show, and sulphides of gold and platinum are so easily and so rapidly formed, we cannot doubt but that sulphur plays a very important part in the solution and translation of these metals from rock masses to intersecting quartz reefs, or from deep strata to superficial positions.

In whatever form, however, sulphur is thus absorbed by sold, it is certainly the greatest obstacle to a thorough and complete amalgamation which we have to contend with; no doubt other substances occasionally intervene to prevent or retard this process, such for instance as the oxides of iron and organic matter, but sulphur and its isomorphs must, I think, be the most actively and the most frequently concerned in this refusal of natural gold surfaces to amalgamate. In case further investigation should prove this sulphurisation of the natural surfaces of gold to be general, it will be easy to look for a remedy against its effects; but, as yet, it would be useless to speculate as to what this should be. As stated, there are several ways of removing these films: perhaps chloride of lime in conjunction with muriatic acid would prove serviceable, but, unfortunately, it could only be applied to the "stuff" before amalgamation, and there might be a loss of gold occasioned by solution.

The sodium amalgam of Crookes would be a safe and certain remedy, and easily applied; its effect would be in relation to this sulphide, to decompose it, and so expose the encrusted gold to the action of the mercury.

Doubtless the great benefit which has often attended the use of this amalgam has been principally due to the exercise of this kind of action.*

* For further discussion on this subject, see *N. Z. Geol. Survey Reports*, 1870, p. 70.

SUGAR FROM MELONS AS COMPARED WITH SUGAR FROM BEETS.

Mr. W. Wadsworth, in a letter to the *Sacramento Union*, maintains that sugar can be made more profitably from melons than from beets. He says:—

The sugar from cane, maple, beets, parsnips, the sweet-gourd, and all the varieties of melons, when manufactured perfectly pure, are chemically identical. In Hungary and Italy there are numerous large establishments for the manufacture of melon sugars. The cost of melon sugar as compared with beet sugar is in favour of the melon. Every German or French authority on the culture of beets for sugar, admits the necessity of two, and recommends three, deep and thorough ploughings of the land to properly fit it for the culture of beets. With melons it is quite otherwise. To secure the largest yield and best beets, the seed should be planted in rows two feet apart, and from eight to ten inches apart in the row. For beets, all the land—for illustration say fifty feet in width—must be ploughed at least twice. For melons, only four beds, twelve feet apart and each only four feet wide, or sixteen feet in width of ploughed land, against fifty for beets, will need ploughing.

The great expense of beet culture is in the hand-hoeing and weeding of every row, and in most lands as many as three of these weedings are required in a season, before the leaves are large and spreading enough to keep down the weeds. The difference between the weeding of four rows of melons and twenty-five rows of beets is very considerable; whilst the exhaustion of the fertility of the soil is in the same proportion. With both crops the land between the rows is kept free from weeds with the horse-hoe or cultivator, at the same expense. Young melon plants are not as tender and delicate for the first eight days as beets. It is evident, therefore, that the expense of culture is largely in favour of melons, it being less than one-third the cost of beets per acre.

In gathering the two crops the difference is again in favour of melons, for they only have to be picked from the vine and thrown into carts; then, without washing or any other process, are ready for the mill. Beets must be first pulled, thrown into heaps to protect them from the sun, then each beet must be handled in having its crown of leaves and rootlets cut off, and then, before it is ready for the rasp or cutter, must be washed thoroughly clean.

The gathering and handling of melons is an agreeable and cleanly operation compared with that of beets. Large quantities of melons in certain localities can be sold for direct consumption in the early part of the season, or whenever worth more in that way than for sugar, spirits, or vinegar; it is not so with beets. Sugar making can commence a full month earlier from melons than from beets, and with winter water melons, as in Hungary, continued as late as with beets. Melons yield their seed every year with no extra expense for cultivation. Beets require a second year, with land, and careful culture and gathering of the seed. Melon seeds will yield sixteen per cent of their weight of excellent table oil. Beet seeds, beyond what are needed for seed, are of no value. The oil from the surplus seeds of melon sugaries in Hungary pays one-half the cost of cultivating the entire melon crop. The yield of melons per acre, in favourable soils, is equal to that of beets. The yield of sugar is as seven per cent from melons to eight per cent from beets; but the cost of manufacture is decidedly in favour of melons; they require less time, less bone-black, less machinery, less power, and less fuel, because no water is added, which cannot be said of beet juice by the ordinary process of extraction.

The natural purity of the juice of melons is so superior to that of beets, that whilst the melons furnish an agreeable "food and drink," and a delicious sweet, the juice of

beets is so acrid and herbaceous to be wholly unpalatable. The defecation and refining processes for melon juice and sugar are therefore attended with far less trouble and cost. That part of the beet which in many instances grows above ground, exposed to the sun, is of little or no value for sugar, whilst the hotter the sun and the drier the air, the better and sweeter the melon. The larger the sweeter generally, whilst the reverse is true of beets.

Beet juice and pulp exposed to the air, will turn black in fifteen minutes, and fermentation commences immediately from the rasp. Melon juice and pulp will not blacken at all, and will not begin to ferment in the open air before the third day from the melon. Beets are remarkable for their power of extracting alkaline and saline substances from the soil, which injures their value for sugar. Melons are equally remarkable for letting these salts entirely alone in the soil.

No centrifugals or presses are required to separate the juice from the pulp, as with beets; but all except the rinds and seeds go into the defecating kettles together. Cloth filters, concentrators, and a vacuum pan are as necessary as for beets. The buildings are less costly, because requiring less strength to hold in position the centrifugals and other necessary machinery for beet sugaries. The chemical processes of melon sugar making do not differ materially from those for the making of beet sugar, except in their simplicity. Spirits in large quantities can be extracted from the fermented juice of melons and the refuse of the sugarie, and "pure cider vinegar" is made therefrom in ten hours that cannot be distinguished from the genuine article. The melon rinds, with dry grass or straw, make an excellent food for milch cows.

USES OF INFUSORIAL SILICA.

INFUSORIAL silica is now employed as a substitute for heavy spar, in the manufacture of certain kinds of rubber goods. As india-rubber will float on water, it is desirable to have something to add to it that is lighter than heavy spar, and the silica seems admirably adapted to take the place of the heavy earth. By mixing three to six parts of infusorial silica to one part of freshly burnt lime, and stamping the whole, after slightly moistening it, into a suitable mould, artificial stone of any desired form can be made. Such stones become extremely hard, are impervious to water, are finer grained than cements or *béton*, can be used for gas or water pipes, and will take any colour. As there are large deposits of diatomaceous earth in various parts of America, this application for artificial stone and cement is well worthy of consideration.

By combining infusorial earth with native magnesite and chloride of magnesium, a cement is produced which is known in Germany under the name of albolith cement. The chloride of magnesium, obtained as an incidental product in salt manufacture, is very cheap in some parts of Germany, and the occurrence of large deposits of magnesite renders this variety of cement available in Europe for many purposes. A fine glaze for earthenware is obtained by fusing infusorial earth with crude borate of lime, or boronatrocalcite. A variety of porcelain can be made by fusing infusorial silica with the borate of magnesia of the Stassfurt mines. This kind of porcelain can be cast, pressed, and, if sufficiently thin, can be blown as easily as glass. It is capable of extensive use in the arts.

Infusorial silica is the best material for absorbing nitroglycerine, in the manufacture of dynamite, and is used for that purpose. Ordinary sand is not sufficiently porous. The ready solubility of this form of silica in soda suggests its application in the manufacture of liquid quartz. It is not a little singular that an earth which has long afforded test objects for microscopists, and has been employed as a polishing powder, should become an article of so much importance in the arts.—*Scientific American.*

ON THE

ESTIMATION OF MANGANESE IN SPIEGELEISEN AND FERRO-MANGANESE.

By THOMAS ROWAN, F.C.S.

THE following process for the determination of manganese is, I need hardly say, not novel; but, having had occasion to make many estimations of manganese in spiegeleisen and ferro-manganese, I can recommend it as superior for speed and accuracy, where manganese in quantity has to be determined, to the other processes commonly resorted to.

A convenient quantity of the sample, say 20 grains, in as fine a state of division as possible, is digested in a long-necked flask, with about 1½ ozs. of hydrochloric acid, until complete solution is effected. The solution is then oxidised with chlorate of potash added from time to time, and finally boiled until traces of chlorine can no longer be detected.

The solution is now saturated by liquid carbonate of soda added in small successive quantities, the flask being well agitated after each addition of the alkali. On nearing the point of saturation, each addition of the carbonate of soda occasions the separation of small quantities of carbonate of iron and manganese, which disappear on the flask being shaken. When this is observed the alkali must be added with extreme caution, but the deep blood-red colour now acquired by the solution will, after a little practice, be a sufficient indication to the operator that the desired point of saturation or neutralisation has been attained. Or, if it is preferred, the smallest excess of carbonate of soda may be added, and the permanent precipitate which forms re-dissolved by the cautious addition of hydrochloric acid, introduced drop by drop.

Before treating with carbonate of soda, the solution should be evaporated to as small a bulk as possible, the presence of much free acid causing the expenditure of an unnecessary amount of alkali, and the violent effervescence caused by the escaping carbonic acid often entails loss by the projections of portions of the solution from the flask.

From 6 to 8 ozs. of water are now added, and the iron precipitated as the basic acetate of iron, by the addition of a concentrated solution of acetate of soda. If the solution has previously been successfully neutralised with carbonate of soda, the ferric acetate will at once make its appearance; but if that point has not been reached, the iron will only precipitate after boiling, and then not completely, and the precipitate will be found to be so gelatinous as to cause much trouble by clogging the filter.

After the addition of the acetate of soda, the flask and contents are briskly boiled for about twenty minutes, and then allowed to repose for a few minutes, that the acetate of iron may settle to the bottom of the flask, when the solution is carefully decanted from it on a filter. More water is then added to the flask, with a few drops of acetate of soda, boiled for five or six minutes, and again decanted from the precipitate. This is repeated a third time. The acetate of iron can then be thrown on the filter and washed with boiling water. The filtrate, with washings, is removed to a beaker and brought to a temperature of about 100° F., and a stream of chlorine gas passed through until a faint smell of that gas can be detected from the liquid. This is ascertained by stopping, from time to time, the passage of the chlorine, blowing from the surface of the liquid in the beaker the gas that may have lodged there, and then testing by the smell. If chlorine can be detected the addition of the gas is finally discontinued. The beaker is now carefully covered and set aside in a moderately warm place for six hours. The precipitated binoxide of manganese is removed by filtration, and chlorine is again passed through the filtrate to ascertain whether all the manganese has

been removed. When the precipitated manganese settles to the bottom of the beaker, if the liquid above is purple-coloured it indicates that an excess of chlorine has been used, and that permanganic acid has been formed. This is easily remedied, as the permanganic acid is at once reduced to the binoxide by the presence of any organic matter. A few drops of alcohol may be added, and the precipitated binoxide of manganese filtered off.

The precipitated binoxide of manganese is re-dissolved by pouring hot dilute hydrochloric acid on the filter. The manganese is re-precipitated as carbonate by a solution of carbonate of soda, and boiled well to expel all carbonic acid, the carbonate of manganese being slightly soluble in carbonic acid. The carbonate of manganese is then collected on a filter, washed well with boiling water, dried, ignited, and weighed as the red oxide.

The binoxide of manganese has such a tendency to appropriate alkali that it cannot be directly ignited to the red oxide. When this is done without re-dissolving and re-precipitating as carbonate, I have found that one part of the ignited precipitate contains 0·0842 of alkali, which must be deducted from the weight before calculating the percentage of metallic manganese.

If the weight of the ignited red oxide thus obtained be 3 grains, the following calculation is made:—

Wt. of red oxide ppt.

1 : 0·0842 :: 3 : 2·7474

In a rigorous analysis, however, it will be found more satisfactory to proceed as directed above, namely, re-dissolve the binoxide of manganese first obtained, and re-precipitate as carbonate before proceeding to ignite and weigh. The amount of metallic manganese is readily ascertained from the weight of the ignited red oxide, 100 parts of which contain 72·05 parts of metallic manganese.—*Engineering*.

A NEW METHOD FOR THE

SEPARATION OF GOLD AND SILVER ON THE LARGE SCALE.

By Dr. F. GUTZKOW.

THE usual method employed on the large scale, for a considerable number of years, for separating gold from silver, copper, and other metals, consists in treating the alloy with concentrated sulphuric acid at a high temperature, and precipitating the silver from its dilute sulphuric acid solution by means of metallic copper, the desilverised liquor being used for the preparation of sulphate of copper. This, however, is in many respects deficient; for, in the first place, there is a large bulk of water required to dissolve the rather difficultly soluble sulphate of silver, and this large bulk of liquid requires, of course, large-sized vessels to hold it. Of far more importance is, secondly, the fact that it involves the production of a large quantity of sulphate of copper, a salt now obtained as a by-product in such large quantities, in various metallurgical and other operations, that, owing to its always yet rather limited consumption, this salt is very difficultly saleable. The manufacturer has, in most instances, to content himself with accepting a price for this article which often only barely covers the expense of the sheet copper employed and the copper present in the alloy which has been operated upon. Taking these matters duly into consideration, the author, who, while residing at San Francisco, in California, was for a series of years the manager of the extensive silver refining works belonging to the San Francisco Assaying and Refining Company, considered it to be of the highest importance to make a radical change in the method of silver refining just alluded to, and to limit the manufacture of blue vitriol to the comparatively small quantity of the copper contained in the crude unrefined ingots. It was found unsuitable to substitute sheet-iron for the sheet-copper in the precipitation owing to the fact that, by the employment of iron, copper is, of course, again precipitated along with the silver; and the separation of the copper from the silver does not admit of any other method readily executed on the large scale than a repetition of the same process again. The author found, however, that the reducing agency of sulphate of iron (green vitriol) can be applied successfully to the solution of sulphate of silver. The process about to be here described has been employed for a series of years in the works above-named, and by this process several thousand hundredweights of fine silver have been produced. It should be observed at the outset that it is not readily possible, for reasons which are not here further alluded to, to work on the large scale with sulphate of iron upon the solution of sulphate of silver in water. On the contrary, it is required to prepare, first, crystallised sulphate of silver, free from impurities, inclusive of metallic gold in finely-divided state, sulphate of lead, and other substances, insoluble in a solution of green vitriol. The pure crystallised sulphate of silver is next to be acted upon by a hot and concentrated solution of green vitriol. The very hot, turbid, thickish fluid obtained by the action of boiling concentrated sulphuric acid upon the silver alloy under operation is poured into a large-sized cast-iron cauldron, containing dilute sulphuric acid at 58° Baumé = 1·617 sp. gr., and previously heated to 110°; a small quantity of water is next added; and after the liquor (having been left at rest for a few minutes) has become clear, the solution is syphoned over into another similar cauldron, so placed and arranged as to admit of being thoroughly cooled by means of cold water externally applied. For every hundredweight of silver refined, 10 cubic feet of the dilute acid (sp. gr. 1·617) are taken. The addition of water just alluded to is intended to reduce the very concentrated acid silver solution to the same density, and the quantity of water to be added may be therefore inferred from this explanation. The addition of water is intended, however, to effect something else yet. Precipitates of sulphate of lead and sulphate of silver are formed, and the latter does not become quite permanent until, first, all the lead which was in solution is precipitated; and, moreover, these heavy precipitates greatly aid the throwing down of all substances which render the liquid turbid, and especially the gold. By the means just described, a clear liquid, quite free from any lead and gold, is far more rapidly and completely obtained than by the method usually applied—viz., the pouring of the very concentrated sulphuric acid silver solution into water.

The liquid, having been cooled in the manner just alluded to, and reduced to a temperature of from 30° to 40°, is, by means of a pump, transferred again to the upper cauldron, there to be used again as acid at 38° B. At the bottom of the cauldron in which the cooling took place the sulphate of silver will be found deposited, forming a hard, yellow-coloured, crystalline crust about 2 inches in thickness. This crystalline mass is tolerably free from adhering acid; but at the deepest part of the vessel will always be found some strongly acid mother liquor, and this acid is to be again used to dissolve a fresh quantity of silver. The crystalline mass, consisting of sulphate of silver, is removed from the cauldron by means of iron shovels, and placed on the perforated false bottom of a wooden box lined inside with lead, and placed on wheels, so as to be capable of being moved from one place to another; between the false and real bottom, a tap is placed for running off liquid. Along with the crystals, and adhering thereto, is a red powder, chiefly consisting of sulphate of copper. The next step is to run through, or, more correctly, pour over, the crystalline mass a very hot and very concentrated aqueous solution of protosulphate of iron (green vitriol). The salt of copper is first dissolved, and therefore that liquid is run off separately, afterwards to be used for the preparation of sulphate of copper. As soon as the solution which runs off begins to exhibit

the pure brown colour due to sulphate of peroxide of iron, the solution is caused to run into a large, very shallow vessel, in which, on cooling, the largest portion of the silver salt is decomposed, and some metallic silver is deposited in a spongy state, which substance is collected and placed on a large filter. The greater portion of the crystalline mass of sulphate of silver which had been placed in the box is, however, converted slowly on into a dense coherent mass of metallic silver, and the reduction may be considered complete as soon as the vitriol solution which runs off has assumed the green colour it originally possessed. The metallic silver is next washed with pure hot water, then pressed in a hydraulic press, and lastly melted.

The iron solution which has collected in the large-sized shallow vessel just spoken of, after having become sufficiently cool, is poured or run into a lead-lined tank wherein some scraps of old sheet-iron are placed, and is thus again re-converted into sulphate of protoxide of iron, to be used at a subsequent operation. The small quantity of silver and copper which are separated in the metallic state by this last-mentioned operation is collected from time to time, and put along with the crystals of sulphate of silver contained in the vessel, wherein they are to be exposed to the action of the sulphate of iron solution. The copper is almost immediately converted into sulphate of copper on coming into contact with sulphate of silver. On the large scale, for every hundredweight of silver reduced from the sulphate 20 cubic feet of green vitriol solution are required.—*Berichte der Deutschen Chemischen Gesellschaft zu Berlin.*

NOTE ON THE ANALYSIS OF MOLASSES.*

By M. A. VIVIEN,
Director of the Laboratory of the Association of Sugar Manufacturers, Paris.

M. DUBRUNFAUT published, in the number of the *Sucrerie Indigène* for June 20, 1870, p. 75, an article in which he tries to prove again that the methods pursued in the analysis of molasses, and considered hitherto exact, are false; from which it follows that all the results given by analytical chemists up to this time, and even until quite recently by himself, are and should be stigmatised as errors. If M. Dubrunfaut has proved what he advances, nothing is to be done but to suppress all chemists, for the manufacturers of sugar can no longer depend upon their dicta. But fortunately one cannot help seeing in this an exaggeration, which it is easy to reduce to the proportions of reality.

How has M. Dubrunfaut discovered that the method usually followed was false? In trying to determine the sugar in a molasses comparatively by a method of his own invention, and by that at present in use, he perceived that these two methods did not give identical results, and he concluded that the one in use was false and that the other was exact.

Still, whatever may be the authority attached to the name of M. Dubrunfaut, to his long experience in the matter, and whatever, on the other hand, may be my personal disqualifications, I do not hesitate to dispute his affirmation, and to call the attention of chemists to a doubtful point, the explanation of which is becoming so much the more urgent as the sale of molasses by analysis tends to become a general custom.

What is the method which M. Dubrunfaut recommends? a faint sketch of it is seen in the number of the *Sucrerie Indigène* for Nov. 5, 1869, p. 201, but the explanation is insufficient to be comprehended by every one; it is also necessary to trace the chemical reactions more minutely. If I understand aright, the method which M. Dubrunfaut recommends is nothing other than the method taught by M. Jacquelin in the laboratory of the Ecole Centrale of arts and manufactures. The following is the method as taken from the laboratory book of the school:—

Determination of Glucose by the Alkaline Method.—In presence of alkalies and under the influence of a temperature of 100° C., glucose has the property of uniting with alkalies, and consequently neutralising their effects; if then we boil a solution of glucose sugar with an excess of soda, it is only necessary to determine, by alkalimetry, the amount of soda which has not been neutralised, to find the quantity of glucose. Crystallisable sugar under the same conditions undergoes no change, and consequently does not saturate the alkali.

Composition of the Solutions—

No. 1. Soda solution (alkaline); 75 grammes of caustic soda are dissolved in distilled water; the solution is diluted up to one litre.

No. 2. Acid solution; 100 grms. of monohydrated sulphuric acid are diluted with distilled water up to the volume of one litre.

These two solutions neutralise each other volume for volume, and the titration is conducted in the following manner:—

Titration of the Solution.—Two grammes of pure dry sugar, to which is added 0·4 c.c. of fuming hydrochloric acid and a small amount of water, are kept for a space of 15 minutes at a temperature of 100° C., easily attained and maintained by means of a water bath. The solution of inverted sugar is diluted to 200 c.c., and consequently contains 1 gramme of sugar in the 100 c.c.; 50 c.c. are taken, which are carefully neutralised with an alkaline solution, say of soda, then we add 10 c.c. of the test soda solution, and the temperature maintained at 100° C. Under these circumstances the glucose neutralises a certain quantity of soda; nothing more remains but to add the sulphuric acid solution in small portions at a time from a graduated burette, and to test, from time to time, by red litmus paper and a trace of the inverted solution, if the point of saturation is reached. The paper cannot be placed in the solution on account of the brownish chestnut colour, caused by the heat, masking every change of colour. To effect the saturation 7·95 c.c. of the sulphuric solution has been used, and 10 c.c. of the soda solution require 10 c.c. of the sulphuric solution; therefore the inverted sugar has saturated the same quantity of alkali that 10 − 7·95 = 2·05 c.c. of sulphuric solution would take up.

Therefore, 1 gramme of sugar made uncrystallisable equals in acidity 0·41 gramme of HO,SO_3. The solutions being titrated, the test of a molasses is as follows:—50 grammes of molasses, average sample, are dissolved in water and diluted to one litre; 50 c.c. of this solution are taken, which corresponds to 2·5 grammes of molasses; this solution should then be ascertained to be perfectly neutral, and then 10 c.c. of the soda solution is added. It is then kept at 100° C. for 15 minutes, and the akalimetric test made. Suppose 8·1 c.c. of sulphuric solution were used, 10 − 8·1 = 1·9 c.c.; therefore, 2·5 grammes of molasses contains a quantity of glucose equal to 1·9 c.c. of sulphuric solution, or, 100 grammes of molasses corresponds to 76 c.c., or we have $4{\cdot}1 : 1 = 76 : x$; from which $x = 18{\cdot}536$ per cent. Therefore, 100 kilos. of molasses contain in glucose what is equal to 18·536 kilos. of glucose sugar. To determine the quantity of sugar in an uncrystallisable state, 50 c.c. of the original molasses solution are again taken, to which is added 1·5 grammes pure HCl, and the solution kept for 15 minutes at 100° C. This is then carefully neutralised, 10 c.c. of the soda solution added, the temperature maintained as before at 100° C. for 15 minutes, and the alkalimetrical determination made. Suppose it was necessary to use 5·8 c.c. of sulphuric solution, we then have $4{\cdot}1 : 1 = 168 : x$; from which $x = 40{\cdot}975$ per cent.

* Translated from the *Sucrerie Indigène* by E. Waller, E.M.

Then 100 kilogrammes of molasses contain—

40·975 sugar in all;
18·536 glucose.

22·430 in crystallisable sugar.

This method was taught some years since at the Ecole Centrale, and it appears to be the one which M. Dubrunfaut recommends and practices. Not only is it false, but it is very difficult of execution. We cannot judge without great difficulty of the exact point of saturation. M. Dubrunfaut, after having praised the saccharometric method, arrives at the conclusion that it is false, the results being varied by the presence of divers organic substances, and noticeably by that of asparagine. M. Dubrunfaut stopped there, and, in spite of his knowledge and perspicacity, he did not perceive that this asparagine falsifies the results if the alkaline method is used, even when taking sucrate of lime. This is what we are about to attempt to show.

A molasses, of whatever origin, is a solution of sugar, of mineral and organic substances. Certain organic substances can, under the influence of heat and prolonged boiling, decompose into multiple products, of which some are acids, and these acids by neutralising the alkali used will be reckoned as glucose. I will only take the case of asparagine, and this example will suffice to prove the fact which I advance. Under the influence of such an alkali as lime, and a temperature of 100°, the asparagine, a neutral body, changes to aspartic acid, with disengagement of ammonia. This reaction takes place during defecation in sugar refining, and is explained by the following formula :—

$$CaO + 2HO + \underbrace{C_8H_8N_2O_6}_{\text{Asparagine.}} = \underbrace{C_8H_7NO_8,CaO}_{\text{Aspartate of lime.}} + NH_3.$$

One equivalent of lime is therefore neutralised by an equivalent of aspartic acid, and the method advised by M. Dubrunfaut may indicate the presence of glucose in a solution which does not contain it at all. Is there any reason, then, to wonder that analytical chemists are unwilling to follow this mode of operation ?

Since the question of the molasses analysis is on foot, I take the opportunity of describing briefly the method of analysis which I practise in order to submit it to discussion.

Every analysis should be made in duplicate, if one wishes to be certain of the figures which he gives; also the analysis of molasses should be made by two distinct methods, care being taken to work upon a sample which is very homogeneous. I operate in the following manner :—

Molasses Analysis.

(1). *Formation of the Average Sample.*—All of the sample to be analysed should be passed through a sieve sufficiently fine to remove from it all foreign bodies, such as black grains, splinters of wood, straw, &c. It often happens that very dense molasses allows sugar to crystallise at the bottom of the bottles; taken hot from the filters it deposits the sugar in cooling, and if care is not taken to re-dissolve the sugar in the average sample its strength will appear too small. The molasses of M. Boulard, sugar manufacturer at Palinges (Saone et Loire), which gave occasion for the article of M. Dubrunfaut, was precisely in this condition, and if all the experimenters have not taken the precaution which I have just mentioned, they have naturally given figures too small.

First Analysis. Crystallisable Sugar.—16·35 grms. of the average sample of molasses are diluted in about 100 c.c. of water and clarified with—

(1). 10 c.c. of a solution of tannin.'

(2). 30 c.c. of a solution of basic acetate of lead at 30° B.

The tannin precipitates the nitrogenous albumenoid substances, of which M. Dubrunfaut could not get rid; it precipitates also the salts of lime, and, moreover, the lime of sucrate of lime, the rotatory power of which falsifies the indications of the saccharometer. The basic acetate of lead is employed in such quantity as to precipitate all the tannin, and to unite all the colouring matter which has not been eliminated by the tannin.

This clarification being terminated, the whole solution is diluted up to 200 c.c. It is then filtered and tested with the saccharometer. The number observed multiplied by 2 gives the amount of crystallisable sugar, excepting a correction which must be applied if there is too much glucose, in 100 kilos. of molasses.

Second Analysis. Total Sugar and Glucose Sugar.—50 grms. of the average sample of molasses are dissolved in water, rendered neutral by very alkaline tartrate of soda, and diluted to 500 c.c. Thus is obtained a first solution (A). This solution, filtered if necessary, is placed in a graduated burette, and run, drop by drop, into 10 c.c. of boiling copper solution of Trommer, Fehling, Barreswil, or others, to complete disappearance of the blue colouration (practice of M. Violette). This copper solution is sufficiently dilute to correspond only to about 0·005 gr. of sugar. 100 c.c. of the solution A is taken, acidulated with 20 to 25 c.c. of tartaric acid (25 per cent solution), the whole maintained at a temperature of 100° for 15 or 20 minutes and neutralised by soda. The solution thus inverted and neutralised is diluted to 1 litre. This solution B is treated in the same manner as has just before been done for glucose, but with a copper solution about ten times as strong. Suppose we have found 20 c.c. solution A to 10 c.c. of copper solution corresponding to 0·00575 of sugar; we have the proportion :—

20·6 : 0·00575 = 1,000 : x ; from which x = 0·028 glucose,

and 10·2 of solution B to 10 c.c. of the copper solution corresponding to 0·0575 gr. of sugar, we have the proportion :—

10·2 : 0·0575 = 10,000 : x ; from which x = 56·37 total sugar.

Finally, supposing that we have found by the saccharometer an observation oscillating between 27·75° and 28° which corresponds to 55·5 or 56, we take the mean and the analysis is interpreted as follows :—

	Per cent.
Crystallisable sugar	55·50
Glucose	2·28
Total sugar	55·78

The inversion by tartaric acid and the neutralisation by soda have the advantage of giving solutions which permit a thorough reduction of the copper solution without allowing at the end of the operation the colouring of the solution with a brown tint which might mask the indications of the final reaction, and prevent the formation of an annular precipitate, while all the sugar is precipitated. In operating thus, results are obtained agreeing within a degree at most; there is no need to seek for greater exactitude in a technical analysis of molasses. Moreover, for a difference of a degree the difference in selling value is much less than that which exists between two analyses of sugar made approximately to ½ per cent—conditions accepted in commercial transactions in sugar. As every one can determine for himself the exactitude of these methods of analysis, I will finish this article by requesting M. Dubrunfaut to examine them and say for himself if he finds them exact; I claim at the same time, in return, his obligation to explain in all its details the method which he considers exact, for we, whom he accuses of being deaf to his advice, know nothing of it.

The 15th of March, 1870, he delivered to M. Monfourny a certificate of analysis of molasses thus expressed :—

The density of the molasses is 41° Baumé.

It contains in crystallisable sugar ..	37·600 per ct.
In actual glucose titrated by sucrate of lime	4·016 ,,
Total in sugar	41·616
Sulphatic ash..	12·384 ,,
In which lime forms a part to extent of	0·353 ,,

The molasses is neutral to litmus paper.

The glucose determined by copper solution gives 7·692 per cent, which constitutes an error of 3·676 per cent more of fermentable sugar if this reagent, employed by many analysts, is used.

Signed, DUBRUNFAUT.

From this, it results that it is erroneous to use the copper method, but *now*, three months after, M. Dubrunfaut does not appear to be of the same mind any longer, since, he says:—"The percentage of sugar may be taken by the copper method, which is very sensitive. . . . We must reject the saccharometer, which gives figures radically inexact."*

What conclusion must we come to? It would be well for the light to be established, and that M. Dubrunfaut, whose ability every one recognises, should assist us to do so.

Finally, I will express my regret that M. Dubrunfaut did not quote in full the certificates of analysis which he pretends are inaccurate. I have in my hands the certificate of MM. Laire and Galot. I only speak of this one, for I have not seen that of M. Zalinski, but I am inclined to believe that M. Zalinski diluted the molasses in such a way as to bring it up to 40° B.† which explains why he found so small a percentage.

	Certificates as quoted by M. Dubrunfaut.		Real certificates.	
	MM. Lair and Galot.	M. Vivien.	MM. Lair and Galot.	M. Vivien.
Degrees Baumé,			41·5	42·05
Weight of 1 hectolitre,				
Crystallisable sugar, per cent	53·35	55·50	53·35	55·50
Glucose sugar, ,,	0·00	0·28	0·00	0·28
Total sugar, ,,	53·35	55·78	53·35	55·78
Ash, ,,	9·76	10·385	8·57	10·336
Which corresponds to a saline coefficient of ,,	5·46	3·34	6·22	5·34

Finally, in taking M. Dubrunfaut's figures as the only exact ones, I do not find a greater difference than 3·55 per cent (55·78—52·222), and not 8 per cent at all. In the same way, between 52·222 and 46·270, I find only a difference of 5·952 per cent, and not 11 or 12 per cent. It would be well, then, to know on what basis M. Dubrunfaut goes to establish the differences which he quotes.

LECTURE EXPERIMENTS.‡

By Professor THOMSEN, of Copenhagen.

Reciprocal Combustion of the Elements of Water.

THIS may be demonstrated very instructively in the following manner. A pair of narrow platinum tubes, 1 centimetre long and 1 m.m. in diameter, are formed up of quite thin platinum foil. These tubuli are melted into a pair of small glass tubes, and are thus made the burners of the two gases, hydrogen and oxygen. The glass tubes are passed through openings about 1 to 1½ centimetres apart in an india-rubber cork. One tube is connected with the oxygen, the other with the hydrogen reservoir. After the cocks of the reservoirs are proportionately opened the hydrogen is ignited. The cork with its two burners is then inserted into a glass tube about 10 to 15 centimetres long, with its upper end much narrowed down, but still left open. The entire apparatus has then the form shown in the following woodcut.

The hydrogen now burns in oxygen, the fusing together of the orifice of the glass tube being prevented by the end of platinum. If, now, the cock of the oxygen reservoir be slowly turned off, and the quantity of oxygen so diminished, the point is soon reached at which the supply becomes insufficient to support the combustion of the hydrogen; the hydrogen flame expands, then disappears for some moments, the flame appears at the oxygen burner, and now without any interruption the oxygen burns in hydrogen. If the oxygen cock be gently opened, the flame withdraws itself to the hydrogen burner, and again hydrogen burns in oxygen. The phenomenon can be repeated as often as desired without extinguishing the flame, provided that the increase or diminution of the stream of oxygen is not made too suddenly.

The experimeut is highly captivating, and it is quite impossible for the observer who has not carefully watched it from the beginning to decide which of the two gases indeed is the combustible one. It shows the reciprocity

of the combustion in the clearest manner. It is evident that while the oxygen is burning an excess of hydrogen issues from the orifice of the large tube and can be ignited there, so that the combustion of hydrogen in the air, and that of oxygen in the hydrogen, can be shown at the same time.

Combustion of Oxygen with a Sooty Flame.

Heavy hydrocarbons, like benzol and oil of turpentine, burn with a very sooty flame; with a very similar flame oxygen also burns in the vapours of these bodies. The experiment is made in the following manner:—Some benzol is warned to the boiling-point in a long-necked flask; the flask is closed by a cork with two holes, through one of which a glass tube of about 1 centimetre bore is passed, and through the other a tube somewhat narrower and bent to one side. When the vapour arrives at the orifice of the wider tube it is lighted, and then a tube, through which a slow stream of oxygen is flowing, is passed down into the flask through the flame. The oxygen tube is bent above, and its mouth is provided with a platinum tube fused into it. A cork upon the oxygen tube closes the wider tube of the flask. The benzol flame is extinguished, and the vapour issues through the side tube, while the oxygen burns in the benzol vapour with a very sooty flame.

Easy Demonstration of Oxidation and Reduction and their Accompanying Change of Weight.

Oxide of copper is rubbed together with some gum-water to a stiff paste, and made into a cylinder of about 1 centimetre in diameter and 3 centimetres in length. It is then dried, ignited, and reduced by hydrogen at a low temperature. The reduced copper has the form of a cylinder, is very porous, but, at the same time, is tenacious

* See last number of the *Sucrerie Indigène* (June 20, 1870), pp. 75—78.
† This practice is pursued in some laboratories.
‡ Translated by Prof. Leeds, from the *Ber. d. Deutsch. Chem. Gesell.* Communicated by the Editors of the *Journal of the Franklin Institute.*

enough not to fall into a powder. It is surrounded with some platinum foil, the end of which is fused into a glass tube. Two tubulated bell-glasses, connected by tubes with gas-holders, are now filled, the one with hydrogen the other with oxygen. The mouth of the hydrogen bell opens below, that of the oxygen above. The gases are now allowed to stream through the bells, the copper cylinder is made somewhat warm without allowing it to attain the point of ignition, and introduced into the oxygen bell. It forthwith ignites and continues to glow until its oxidation is complete. Then it cools off, and the light dies away. When taken out of the oxygen and put in the hydrogen bell it begins to glow fiercely again, much water condenses upon the sides of the bell, while the cylinder is reduced to metallic copper. We have here the highly interesting phenomenon of a body which burns twice in succession, first in oxygen and then in hydrogen, and both times with the same intense light and heat. After the second burning it is the same body as in the beginning. Since the change of weight in such a cylinder amounts to a gramme, the addition and subtraction can very easily be verified by a common balance.

NOTE ON THE ANALYSIS OF CHROME-IRON ORE.

By J. E. STODDART.

In "Select Methods of Chemical Analysis," page 54, is given a method for estimating chromium, by Professor Storer, which is said to be applicable to such compounds as chrome-iron ore.

This method consists in oxidising the chromium compound by means of nitric acid and chlorate of potassium; chromic acid is then formed, and estimated in the form of chromate of barium.

Being engaged in the analysis of chrome-iron ores, and this process seeming to promise good results in a short time, I made trial of it, under the direction of Professor Thorpe.

Half a gramme of the ore, pulverised to an impalpable powder, and then passed through very fine muslin, was heated with nitric acid and chlorate of potassium, in an evaporating dish as directed in the process. After an hour's heating, which is considerably longer than the time given by Professor Storer, there still remained some of the ore undecomposed, which after fusion with carbonate of sodium and nitrate of potassium, and treatment with boiling water, yielded a tolerably large precipitate of chromate of lead, on the addition of excess of acetic acid and acetate of lead.

This result seems to show that even after an hour's treatment with nitric acid and chlorate of potassium there still remains a pretty large amount of undecomposed chrome ore, and that therefore this method does not present any great advantage over the ordinary, although somewhat more tedious, process of fusion.

Laboratory, Andersonian University,
Glasgow.

NOTICES OF BOOKS.

Chemical Note-Book. London: S. Deacon, 30, King Street, Borough, S.E.

This useful work will be found a boon to pupils, as well as to teachers, especially by insuring uniformity in making notes of experiments. Its arrangement and intended use may best be shown by the reproduction, on a smaller scale, of one of its pages, which reads as follows:—

Description of Substance

Deportment of Solution with Reagents

Hydrochloric Acid.	Sulphuretted Hydrogen.	Ammonic Sulphide.	Ammonic Carbonate.	Sodic Phosphate.

Additional Experiments for the Detection of Metals

Experiments for the Discovery of the Non-Metallic Constituents

Name of Substance

Confirmatory Experiments

CORRESPONDENCE.

ATOMIC VOLUMES.

To the Editor of the Chemical News.

Sir,—As you have favoured me by the insertion in your issue of the 26th of May, of some brief remarks upon the doctrine of "atomic volumes," I may, perhaps, be permitted to offer a few additional observations in relation to it.

In further illustration then of my own humble views, I would call attention to marsh-gas, H_4C, as another well-known typical compound, formed of 1 volume of carbon-vapour, C = 12, and 4 volumes of hydrogen, $H_4 = 4$, and, like the compounds to which I have before referred, viz., HCl, H_2O, and H_3N, presenting in the combination of its elements, a double product volume.

In this case, as the single volume of carbon vapour exists in equal proportions in each of the two compound volumes of H_4C, it follows, according to the reasoning in my previous communication, that it must be regarded as *at least* halved in the combination, like the single atomic volume of H and Cl, of O and of N, in the above compounds respectively. The atomic volume combining weight of carbon vapour would, in this point of view, be 6 instead of 12, as generally received. If, however, we consider more closely the constitution of H_4C, and bear in mind that the single volume of C, and the 4 volumes of H are not simply mixed, but *chemically combined*, in the condensed double compound volume, we can, I think, but conclude that an equal proportion of this 1 volume of carbon must be associated with each of the 4 hydrogen volumes; or, otherwise expressed, that the unit volume C is separated or divided into four in the formation of the product volumes H_4C, just as I have ventured previously to hint that the single volume of N is divided into three in H_3N. Should this deduction be correct, it will be necessary still further to divide the present atomic volume weight of C, and represent it by $\frac{12}{4}$, or 3, in lieu of either 12 or 6.

It is evident that a multitude of other compound gases may be viewed in the same light relatively to the *single* elementary volumes that enter into them, and that, accordingly, as I have presumed to infer, the atomic or combining weights of the elements should be regarded as strictly multiples of the true atomic volume weights. This theory is also supported by the fact that, in the case of mercury, Hg, 200, and of cadmium, Cd, 112, the atomic weights are *double* the respective vapour densities of those bodies.

I fear that I have already trespassed upon your valuable pages, and, therefore, will conclude in the words of one of our most distinguished chemists, Dr. Hofmann, "we are liable (speaking of bodies that he refers to) to be misled by analogy: to assume, for example, coincidence

of the *combining* weight with the *volume* weight, whereas, in truth, there may be, as in the cases of phosphorus and arsenic, *no such coincidence*, but an exceptional divergence; the combining weight corresponding to half the volume only, not to the full volume of the gas, or even, perhaps, standing in *some less simple ratio* thereto."*—I am, &c.,

W. H. O.

Mildmay Road, Stoke Newington.
June 9, 1871.

MAGNETIC CURVES.

To the Editor of the Chemical News.

SIR,—As I take great interest in lecture illustrations I was much pleased to read Dr. Mayer's article on the exhibition of magnetic curves. Would you allow me to say that a somewhat similar method to the one Dr. Mayer describes is in use by Mr. W. F. Barrett, of the International College.

Instead of using shellac, Mr. Barrett uses a solution of gum, which is allowed to dry on a piece of glass, and when the figures are obtained, they are fixed by breathing on the gummed glass. I would mention, too, that I have used, at Mr. Barrett's suggestion, the lantern I devised for cohesion figures with very satisfactory results. This lantern allows the slide to be horizontal, so that the actual formation of the curves is seen on the screen when the slide is tapped. One of my pupils, Mr. Anderton, used, some years ago, a similar method to that of Dr. Mayer, only instead of shellac as a cementing material, canada balsam was used.—I am, &c.,

C. J. WOODWARD, B.Sc.

Midland Institute, Birmingham.
June 10, 1871.

PALM OIL.

To the Editor of the Chemical News.

SIR,—If your space should permit it, will you allow me to append to the article on palm oil (by M. Gaston Tissandier), a few words, which, by preventing misapprehension, may render the information given more useful.

To many users of palm oil, the colour is of small importance, except in so far as it marks freedom from dirt and from some objectionable admixtures. Those who bleach the oil, look, I believe, not so much for an oil of *deep* colour as for one of *bright* colour. The brilliant orange-scarlet of fine Lagos oil is their desideratum. To makers of stearine, the "hardness" of the oil, that is, the proportion of hard fatty acids obtainable, is the important consideration.

I never saw a palm-oil adulterated with "fifty per cent of water." Parcels of oil occasionally come in, which give from ten to eighteen per cent of water, but these are classed with certainty under the head of "wet and dirty oil," and are very commonly valued with much accuracy by the samplers, who use no chemical test of purity, but simply inspect the samples when drawn. I think it would be difficult to induce a good palm-oil sampler to pass as "clean and merchantable" an oil containing ten per cent of water. But a mixture of two parts oil and one part water would need wonderful skill in mixing to render it passable as "clean."

To the notice of the oil, which may be expressed from the kernels of the palm nuts, it is desirable to add, that although it may be of "superior quality" in some points, yet it is quite different in character from the true palm-oil of commerce, which covers the outside of the nut as it grows. The palm-kernel oil is almost or quite useless for many purposes to which palm-oil is applicable. And an addition of the kernel-oil to the palm-oil, so far from raising the value of the latter, would lower this value considerably to almost all ordinary consumers of the article.—I am, &c.,

W. H. H.

Belmont Works, Battersea.

* "Modern Chemistry" p. 97.

MISCELLANEOUS.

Geologists' Association.—On the 2nd inst. an important paper was read at a meeting of this society by M. Hawkins Johnson, Esq., F.G.S., on the "Origin of Flints, and the Process of Silicification in General." After alluding briefly to the different modes in which these substances occur, the author proceeded to show that their formation is due to a chemical process which may be roughly expressed, in technical language, as the substitution of silicon for carbon. He pointed out how a crop of sponges invested with their gelatinous flesh or sarcode, and living at the bottom of a deep ocean, were suddenly buried in a thick stratum of white mud, consisting of the minute shells of *Foraminiferæ* that they then died, and while in the process of decomposition, this interchange of materials took place,—the nascent carbonic acid parting with its carbon in exchange for the silicon of the silicate of soda which sea-water is known to contain. At the close of the paper, the author produced a tadpole, upon which he had experimented, and which he had that afternoon subjected for two hours and a half to the action of nitric acid, without its undergoing any alteration, the inference being irresistible that the animal had become invested with a film of silica of sufficient thickness to protect it from the acid; another tadpole that had not undergone the same preparation having been converted into a brown cloud by immersion in the acid for the same time. The importance of this discovery in connection with the arts can scarcely be over-estimated; for the protection of perishable surfaces from decomposition is a desideratum that forces itself upon our notice daily.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Annalen der Physik und Chemie, von Poggendorff, No. 3, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Thermo-Chemical Researches.—Dr. J. Thomsen.—The continuation of a very lengthy monograph on this subject, this ninth section treating on the specific heat of aqueous solutions.

Experimental Optical Researches.—Dr. G. Quincke.—The concluding section of a lengthy monograph treating on Newton's coloured rings between surfaces of glass and metal.

Apparatus for Demonstrating the Axiom of the Paralellogram of Forces and the Laws of Equilibrium on an Inclined Plane.—G. Krebs.—A lengthy paper illustrated by several engravings.

Observations on the Theory of Capillary Phenomena.—A. Mousson.—An algebraico-physical essay illustrated with woodcuts.

Three Methods of Estimating the Resistance of Induced Currents.—Dr. F. Kohlrausch.

Reduction of the Second Axiom of the Mechanical Theory of Heat to General Mechanical Principles.—Prof. R. Clausius.

Limits of Applicability of the Law of Lenz-Jacobi.—Dr. A. von Waltenhoven.

Double Chloride of Zinc and Ammonium formed in Leclanché's Manganese Galvanic Element.—E. Priwoznik.

—This paper contains, in the first place, the detailed crystallographical description of the crystals just alluded to, illustrated by a woodcut. The composition of the crystals is, in 100 parts:—Zinc, 38·31; chlorine, 41·71; ammonia, 19·98. Formula, $ZnCl_2(H_3N)_2$. The chemical process by which it is formed in the Leclanché's cell is expressed by $2H_4NCl+Zn+2MnO_2=2H_3N+ZnCl_2+Mn_2O_3+H_2O$.

Determination of the Temperatures of Fusion and Solidification of Fatty Substances.—Dr. Th. Wimmel.—This paper contains a critical review and observations on an essay on the subject just alluded to, published in this periodical (vol. cxl., p. 420) by Dr. F. Rüdorff. The author of this paper states that fats exhibit two different temperatures of solidification (*erstarrungspunkte*) —one a natural, and another which might be termed artificial—the former of which, although not exactly coinciding with the fusion-point, is, at any rate, the most constant, and more readily determinable. The author points out the very great discrepancies existing between the various observations made by different authors on the fusion-point of the same kind of fat, adducing, as an instance, that beef suet, according to some authors, fuses at 37·6°, and, according to others, at 59·6°, and the same holds good for other fatty bodies, inclusive of Japan wax.

Observations on Prof. A. Heller's Memoir on Measuring the Intensity of Sound.—Dr. A. Scebeck.

Reply to Dr. Kenngott on his Remarks upon my Analysis of Chabasite.—Dr. C. Rammelsberg.—A vindication of the author's character against the insinuation made that he falsifies results of analysis.

Derivation (Ableitung) of the Behaviour of Gases towards Heat (Wärmeverhältnisz) under Constant Pressure and Volume $\left(\frac{c}{c'}\right)$ from the Mechanical Theory of Heat.—Dr. F. Mohr.

Description of a New Microscope Constructed by R. Winkel.—Prof. J. B. Listing.—It appears that the instrument here alluded to, made at Göttingen, is a masterpiece of good workmanship, the maker having especially taken care to guard against the deterioration of the lenses by the action of air and moisture, by reducing to a minimum the quantity of oxide of lead used in the composition of the glass the lenses are made of. In other respects, the instrument is not above those made by celebrated London and Paris microscope makers.

The American Journal of Science and Arts, May, 1871.

This number contains the following original papers relating to chemistry and allied sciences:—

Estimation of Phosphoric Acid.—C. E. Munroe.—Reserved for reproduction, an observation also applicable to the following paper, by the same author:—

Use of Porous Cones in Filtration.

Existence of the so-called Compound Ammonium-Amalgams.—By the late Dr. C. M. Wetherill.—This paper contains, in the first place, an account of the results of the experiments made at various periods by different scientific chemists for the purpose of obtaining amalgams with the so-called compound ammoniums. Next follows the minute description of the preparation of methyl-ammonium oxalate by Lea's process; and, lastly, the author states that a portion of fluid sodium-amalgam, the size of a pea, was placed in a small test-tube (¼ inch diameter), and the solution of methyl-ammonium oxalate added, the swelling was observed, both with and without shaking, in the cold and warm. The same experiment was performed with different specimens of methyl-ammonium oxalate; in some instances the swelling was from 8 to 10 times the original volume, which was very much less than the turgescence of the ammonium salt. The methyl-ammonium amalgam presented the same buttery appearance as the ammonium amalgam. When the lump was pressed between two plates of glass, myriads of gas bubbles were apparent; when these were pressed out, the amalgam was at once restored to the condition of mercury. A piece of filter-paper was placed upon a glass plate, then saturated with a strong solution of the re-crystallised methyl-ammonium oxalate; a globule of mercury the size of a small pea was placed upon the paper with the negative poles of twenty Bunsen cells in contact with it, the positive pole touching the paper; the globule of mercury swelled slightly, presented a buttery appearance, attached itself to and amalgamated the blade of a penknife which was in contact with the negative pole, and, upon being pressed under a glass plate, showed innumerable gas bubbles in its substance—in fact, was a metallic froth. It results from these experiments that the compound ammonium examined by this author may form the so-called amalgam.

This number also contains several valuable papers bearing upon natural history and geology.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, April, 1871.

This number contains the following original papers and memoirs more particularly relating to chemistry:—

A Practical Method for Preparing Lactic Acid.—Dr. C. O. Harz.—This lengthy memoir contains a review of practical applicability of the various methods in use, and prescribed in pharmacopœiæ, for the preparation of lactic acid. The author, after having made a series of experiments on this subject, found that, by using the following prescription, lactate of soda and other lactates may be readily prepared:—Take of milk sugar, 3 parts; water (not distilled, but good spring or river water), 36·0; a flour rich in gluten (the author has successfully employed the well-known *farina hordei præparata*), from 0·50 to 0·75 parts; beer yeast, one or two large-sized table-spoonfuls; crystallised carbonate of soda, 6 parts, or bicarbonate of soda, 3 parts. The essay further treats, at length, on the mode of preparation of various lactates as required in pharmacy.

Action of Carbolic Acid and Creosote upon the Animal Organism.—Dr. Th. Husemann.—A lengthy, but valuable, physiological essay.

As a curiosity, taken from among the secret remedies, the analyses of which are quoted in this number, we copy the following:—

Lemonade for Strengthening the Memory.—G. M. Raufer.—The author puffs up, and sells for three shillings, a quantity of fluid, about 30 grms., containing 15 parts of phosphoric acid, 15 of glycerine, and 70 of water. This stuff is sold in Vienna.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, April, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Subjective Colours of the Double Figures (Doppelbildern) of Coloured Glass Plates, and on the Colours of Thick Plates.—Prof. Dove.—An optico-physical essay which, although of great value, does not admit of any useful abstraction.

Composition of Native Compounds of Niobium and Tantalum in General, and more especially on that of Tantalite, Columbite, and Pyrochlor.—Dr. C. Rammelsberg.—This monograph is divided into the following sections:—History of the discovery and earlier researches of the group of bodies alluded to; brief account of the labours of MM. Rose, Marignac, Blomstrand, Roscoe, and Deville on this subject; tantalite and columbite—older analysis; exhaustive account of the results of analysis of six different specimens of tantalite investigated by the author; analysis of several specimens of pyrochlor and columbite. This monograph is not quite complete; the author states that he will also publish his researches on fergusonite, yttro-tantalite, euxenite, and other members of the tantalum group, and a general retrospective review of all these researches.

Bayerisches Industrie und Gewerbs Blatt, March, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Most Prominent Objects of the Industrial Exhibition held at Cassel last year, considered in a Technical, as well as Industrial, point of view.—Dr. E. Wiederhold.—The continuation of an excellent descriptive review, copiously illustrated with engravings, of the most useful and best-executed apparatus and tools intended for application in various ways; among these gas apparatus intended for use in localities where no large gas-works exist, or are near enough, occupy a prominent place, especially as regards the manufacture of gas from petroleum distillation, oil residues, and paraffin oil. Attention is also called to lucifer matches prepared entirely without phosphorus, either in the composition or on the paper intended for igniting them by friction. MM. Kalliwoda and Co., at Ortenberg (Grand Duchy of Baden), prepare a composition the essential ingredients of which are chlorate of potassa and hyposulphite of lead; the lucifer matches dipped with this composition ignite readily by friction on any rough surface, and are a little less costly than those containing phosphorus.

Recent Improvements made in the Wine Industry.—Dr. Ph. Neumann.—This lengthy memoir contains an excellent review of all that has been done of late years to improve the modes of making must, fermenting it, and all the novelties introduced to preserve wine by heating it, application of electricity, filtration, &c. We learn from this essay that in the wine-producing parts of Germany the manufacture of cognac from wine has become a profitable business, although the wines employed for this purpose are naturally less rich in alcohol than the French wines.

Annalen der Chemie und Pharmacie, May, 1871.

This number contains the following original memoirs and papers:—

Contribution to our Knowledge of the Sulpho-Nitrogen Acids.—Dr. A. Claus.—The continuation and end of this very lengthy and exhaustive monograph.

Normal Butylic Alcohol.—Drs. A. Lieben and A. Rossi.—Of this exhaustive monograph, the chief results were published in *Comptes Rendus*, vol. lxviii., p. 1561. The following are the headings of the sections contained in this memoir:—Review of the labours of Drs. Wurtz, Chancel, Fayet, Kolbe, and others on this subject; preparation of butyraldehyde; butylic alcohol; oxidation of butylic alcohol; butylic chloride; butylic bromide; butylic iodide; butyl-ethylic ether; butylen; butylic acetate; butylic butyrate; butylic cyanide; butylamine; constitution of the normal butylic alcohol, and general observations. From the latter we quote the following:—If we compare the boiling-points of the now known four isomeric butylic alcohols together we find that the boiling-point of the tertiary butylic alcohol is the lowest, that of the normal butylic alcohol the highest, and that, starting from the first-named, the differences between the cyphers indicating the boiling-point decrease, as is exhibited by the following tabulated review:—

	Normal butylic alcohol.	Fermentation butylic alcohol.	Secondary butylic alcohol.	Tertiary butylic alcohol.
	$C\begin{cases}CH_2.CH_2.CH_3\\H\\H\\OH\end{cases}$	$C\begin{cases}CH(CH_3)_2\\H\\H\\OH\end{cases}$	$C\begin{cases}CH_2.CH_3\\CH_3\\H\\OH\end{cases}$	$C\begin{cases}CH_3\\CH_3\\CH_3\\CH\end{cases}$
Boils at—	116°	109°	99°	82°
Difference—		7°	10°	17°

Normal alcohols may be defined as those which, of all isomeric alcohols, have—(1) The highest boiling-points, and are the most stable; (2) the simple and compound ethers of which, as, also, the amines thereof, have relatively the highest boiling-point, and the haloid combinations of which are least readily split up by the throwing off of CnH_{2n}; (3) when oxidised, these bodies yield acids containing the same number of carbon atoms, and are distinguished from eventually (*eventuellen*) isomeric acids, by having a higher boiling-point and more power of resisting oxidation.

Investigation of a Himalaya Tea.—Dr. P. Züller.—This paper contains the results of a series of experiments made with a sample of very fine tea, a small quantity of which had been sent to Prof. J. von Liebig by a proprietor of tea plantations. 100 parts of the tea contained 4·95 of water and 5·63 of ash, which, in 100 parts, was found to consist of—Potassa, 39·22; soda, 0·65; magnesia, 6·47; lime, 4·24; peroxide of iron, 4·38; manganoso-manganic oxide, 1·03; phosphoric acid, 14·55; sulphuric acid, a trace; chlorine, 0·81; silica, 4·35; carbonic acid, 24·30. Extract soluble in water of this tea amounted to 36·26 per cent. The nitrogen in the air-dried tea was found to be 5·38 per cent. In addition to 4·94 per cent of theine, this tea was found to contain some theobromine. The quantity of nitrogen in the extract (that is, the portion of the tea soluble in water by infusion), dried at 100°, is 10·09 per cent, while the ash therein amounts to 11·46 per cent. The author concludes by stating that this tea is equal to the best Chinese tea, and that the younger the leaves of the shrub the better the tea they yield.

Decomposition of Acrolein Ammonia by Dry Distillation.—Dr. A. Claus.—The result of the author's researches prove that acrolein ammonia yields, by dry distillation, a volatile base, which is, however, while volatilising, partly decomposed. The crude oily product of the dry distillation yields, when submitted to distillation at from 120° to 150°, a volatile base (a new compound) which has a constant boiling-point, and is picoline.

Further Researches on Propargyl Ether.—Drs. C. Liebermann and O. Kretschmer.

Oxypicric (Styphnic) Acid.—Dr. J. Schreder.—The author, in the first portion of this lengthy memoir, proves the identity of styphnic acid, $C_6H_3N_3O_8$, with the trinitro-resorcin of Weselsky, the quantities of carbon and hydrogen in these substances having been found to amount, respectively, to 29·41 and 29·42 and 1·64 and 1·62. The memoir is further divided into the following sections:—Triamido-resorcin; hydrochlorate of amido-diimido-resorcin.

Basicity of Gluconic and Lactonic Acids.—Prof. H. Hlasiwetz.—The contents of this paper are mainly devoted to a critical review of Dr. Fittig's essay "On the Constitution of the so-called Carbo-Hydrates," separately published under the following German title:—"Festschrift zer Feier des Geburtstages Sr. Maj. des Königs von Würtemberg," Tübingen, L. F. Fues, 1871. However valuable the above-named paper may be, it is not well suited for abstraction, chiefly on account of the very large number of lengthy and complex formulæ which would require to be reproduced, an observation which equally applies to the two following papers:—

Formation of a Methyloisethionic Acid.—Dr. E. Erlenmeyer.

Lactic Acid contained in Muscular Tissue.—Dr. E. Erlenmeyer.

Polytechnisches Journal von Dingler, first number for May, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Observations on the Application and Caloric Statistics of Reverberatory Furnaces to Iron-Foundry Purposes.—Dr. E. F. Dürre.—A lengthy monograph of considerable value in reference to reverberatory furnaces in general, and the best mode of constructing them so as to utilise all the available heat of the fuel.

Henderson's Patented Method of Separating Phosphorus from Crude Cast-Iron.—P. Tunner.—Mr. Henderson's method, patented in New York, is fully described in the *Engineer* of the 17th of February last (p. 110). The author does not state anything new on this subject.

M. Kröncke's Method of Amalgamating Silver Ores, as used at Copiapo, Chili.—Dr. L. Eich.—The method alluded to may be summarised in the following manner:—The use of a hot and concentrated solution of protochloride of copper (*kupferchlorür*) and common salt—the latter serving the purpose of keeping a larger quantity of the former salt in solution, and avoiding the formation of basic salts of copper. The use of perfectly dry and very finely ground up ore, so that the solution just alluded to may thoroughly penetrate; wet, or moist ore, moreover, causes the formation of basic salts of copper, and thereby loss of active protochloride of that metal. Use of lead and zinc along with mercury and the protochloride of copper, in such quantities that the reactions take place according to the following formulæ:—

$$3AgS,SbS_3+3Cu_2Cl+NaCl=3AgS+SbCl_3+3Cu_2S+NaCl,$$

and

$$AgS+Cu_2Cl+Zn+NaCl=Ag+Cu_2S+ZnCl+NaCl.$$

Lastly, the materials (ores) to be operated upon should always, as much as possible, be of the same richness and quality throughout.

Chemical Analysis of a Cement-Stone.—Dr. E. Reichardt.—The portion soluble in hydrochloric acid, amounting to 89·16 per cent, was found to consist of—CaO,CO_2, 49·84; MgO,CO_2, 26·96; CaO,SO_3, 0·36; Fe_2O_3, 3·83; FeO, 4·17; MnO, 0·22; NaO, 0·40; KaO, 0·35; SiO_2, 2·96; HO, 0·66. The rest, insoluble in hydrochloric acid, consists of—CaO, 0·76; MgO, 0·14; Fe_2O_3, 0·60; Al_2O_3, 1·60; KaO, 0·13; NaO, 0·19; SiO_2, 3·78; sand, 3·26.

Transparent Aniline Lakes and the Colouration of Mica.—F. Springmühl.—This paper treats, at great length, on the preparation of varnishes coloured with various aniline and other similar colours.

Method for Recovering Tartaric and Oxalic Acids from so-called Dischargers, and on the Use of Hypochlorite of Soda (Eau de Labarraque), instead of Bleaching Powder, as Discharge for Turkey-Red Dyed Fabrics.—Dr. A. Müller.

Sugar Refined with Sulphurous Acid according to Dr. Seyfert's Process.—Dr. P. Schulze.—This essay treats, at great length, on the effect of this process upon the refined sugar, as detectable by a peculiar taste and by its becoming yellow, and on the precautions refiners have to take when applying the sulphurous acid gas.

Valuation of the Quantity of Oil contained in Oil-Seeds.—Dr. H. Vohl.—A lengthy memoir, accompanied by the engraving of an ingeniously-contrived apparatus for the accurate estimation of the oil contained in various seeds.

Manufacture of Benzoic Acid from the Urine of Horses and Cattle on the Large Scale.—C. J. Kaufmann.—The author's exact process is not described, but, from 35,000 cwts. of urine, annually 70 cwts. of pure benzoic acid are prepared, which is chiefly consumed in England and France in the manufacture of aniline colours.

Method of Distinguishing Chloroform made from Chloral from Chloroform made from Alcohol and Bleaching-Powder.—Dr. Hager.—In the first place, the former chloroform, known now on the Continent as "English chloroform," has a sp. gr. of only 1·485, and contains, according to the author, from 0·75 to 0·8 per cent of strong alcohol. When, to the chloroform prepared from alcohol and bleaching-powder, strong sulphuric acid is added, it always becomes more or less coloured, which does not happen to be the case with the chloroform prepared from chloral; when, moreover, a few drops of each kind of chloroform are left to evaporate spontaneously upon a watch-glass, the chloroform prepared with alcohol gives off, after a while, a disagreeable smell, while the other kind retains until complete volatilisation its pleasant fruity odour.

Journal für Gasbeleuchtung und Wasserversorgung, No. 8, 1871.

This number contains, besides a series of papers strictly relating to gas and waterworks' engineering, the following information relating to—

Carboxygen Illumination.—Dr. J. Philips.—The carbolin (the fluid used in the lamps invented by the author) costs about the same as petroleum—that is to say about 6d. per Prussian quart (1·145 litres). The hourly consumption of carbolin, amounting, on an average, to 30 grms., will cost about one halfpenny. As regards the price of the oxygen gas (an artificial air containing from 50 to 75 per cent of oxygen), it is stated that this may be prepared on the large scale at a cost of 15 centimes (2½d.) per cubic metre (a little more than 35 English cubic feet). The carboxygen illumination is daily gaining ground in Cologne, Brussels, New York, and other places. This light is also employed now in some large hot-houses where plants and shrubs are exhibited, the colours of leaves and flowers seen by this light being seen exactly as in daylight, while there is no danger of injuring the most tender and delicate plants, as there is with other artificial modes of lighting.

No. 9, 1871.

This number does not contain any other matter except what strictly belongs to gas and waterworks' engineering and management.

Les Mondes, March 23, 1871.

Recent unfortunate occurences have caused a long delay in the transmission of this number, which, among a great variety of other very readable and excellent matter, contains the following, relating more particularly to chemistry and collateral sciences:—

New Plastic Material.—Rev. F. Moigno.—Very pure and very finely-pulverised phosphate of lime (bone-ash) is made into a paste by means of collodium. After having become dry, this substance becomes very hard, and assumes an excellent polish.

Collodium Prepared with Silk.—Rev. F. Moigno.—Pure silk is soluble in hydrochloric acid. If this solution is first neutralised by ammonia, and next evaporated at a gentle heat, the residue yields an organic chloride of ammonium suitable for photographic use.

Chemical Investigation of the Black-Coloured Matter of the Tadgerite.—Dr. S. Meunier.—By tadgerite is understood the stony matter which constitutes the meteorite fallen at Tadgera, near Sétif, Algeria, on the 9th of June, 1869. The author comes to the conclusion that the blackish colouration which obtains in grey-coloured

meteorites by the action of heat is due to the separation, in these substances, of a peculiar compound of peridotic nature; this separation is due to a kind of liquation of the silicates, especially those whereof the composition is akin to that pyroxen and amphibole. The author calls attention to the fact that the heating to redness of a small fragment of meteorite may often give a precious clue to its mineralogical composition; so treated, for instance, the meteorite of Montréjeau exhibits irregular-shaped granules upon a whitish ground, which granules are not rendered manifest by analysis. The Pultusk meteorite exhibits colourless grains, which act strongly upon polarised light and are invisible before the stone is heated to redness.

Bulletin de l'Académie Impériale des Sciences de St. Petersbourg, vol. xvi., No. 1, 1871.

This number only contains the following original paper bearing on chemical science:—

Place of Cerium in the System of Elementary Bodies.—Dr. D. Mendéleyef.—Since the value of this lengthy and learned memoir almost entirely depends upon the reproduction of a series of formulæ, as well as upon that of a tabulated review of the system of the elements, divided and arranged according to the author's views into eight groups, each sub-divided again into ten typical series, it is not possible to give here an abstract of this highly scientific memoir, in which, moreover, several references occur relating to papers published by the author in the Russian language.

NOTES AND QUERIES.

Hydrate of Chloral.—Being anxious to make some pure hydrate of chloral, I shall be glad if you will inform me of the best and simplest method of making it, and purifying it when made?—W. E.

Disulphide of Carbon.—I should be glad if you or any of your correspondents would kindly tell me if the demand for disulphide of carbon is good; also, where the market is for the same, and what the price is per pound.—SULPHUR.

Estimation of Sulphur in Dense Coke.—Can any of your readers inform me of a good method for the estimation of sulphur in *very dense* coke? The methods I have tried do not yield very accurate results, on account of the high temperature required for decomposition.—S. REDDROP.

Carbolic Acid.—(Reply to W. G. Holding.)—To obtain the acid in dry state, recourse must be had to digestion with chloride of calcium, followed by a new rectification. If required pure, only that portion which boils at 370° F. must be received; the distillate, by refrigeration, furnishes crystals of the acid, which must be drained, dried, and preserved from the air.

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THE CHEMICAL NEWS.

VOL. XXIII. No. 604.

EXAMPLES FOR PRACTICE IN QUANTITATIVE ANALYSIS.

By ALEXIS A. JULIEN.

THE following examples in quantitative analysis are executed in the School of Mines, Columbia College. As the atomic weights employed in calculating the results of analyses have been corrected from time to time by more accurate determinations, I give at the outset the latest numbers.

TABLE I.—ATOMIC WEIGHTS.

H = 1.

	O=8.	O=16.		O=8.	O=16.
Al	13·7	27·4	Hg	100·0	200·0
Sb	122·0	122·0	Mo	48·0	96·0
As	75·0	75·0	Ni	29·0	58·0
Ba	68·5	137·0	N	14·0	14·0
Bi	210·0	210·0	Os	100·0	200·0
B	11·0	11·0	O	8·0	16·0
Br	80·0	80·0	Pd	53·0	106·0
Cd	56·0	112·0	P	31·0	31·0
Cs	133·0	133·0	Pt	98·7	197·4
Ca	20·0	40·0	K	39·0	39·0
C	6·0	12·0	Rh	52·0	104·0
Ce	45·7	91·4	Rb	85·4	85·4
Cl	35·5	35·5	Ru	52·0	104·0
Cr	26·1	52·2	Se	39·5	79·0
Co	30·0	60·0	Si	14·0	28·0
Cb	94·0	94·0	Ag	108·0	108·0
Cu	31·7	63·4	Na	23·0	23·0
Di	47·5	95·0	Sr	44·0	88·0
E	56·3	112·6	S	16·0	32·0
F	19·0	19·0	Ta	182·0	182·0
Gl	4·6	9·2	Te	128·0	128·0
Au	197·0	197·0	Tb	75·0	75·0
H	1·0	1·0	Tl	204·0	204·0
In	72·0	72·0	Th	119·0	238·0
I	127·0	127·0	Sn	59·0	118·0
Ir	99·0	198·0	Ti	25·0	50·0
Fe	28·0	56·0	W	92·0	184·0
La	46·0	92·0	U	60·0	120·0
Pb	103·5	207·0	V	25·6	51·2
Li	7·0	7·0	Y	30·8	61·6
Mg	12·0	24·0	Zn	32·5	65·0
Mn	27·5	55·0	Zr	44·8	89·6

Strength of Reagents.

The reagents used in the laboratory are all prepared with the strength recommended by Fresenius in his "Manual of Qualitative Chemical Analysis." By the use of the following table, the amount of a reagent required for any precipitation can be readily calculated; though in actual practice it is generally advisable to employ a few more cubic centimetres, and also to add a few drops, first to the supernatant liquid, and afterward to the filtrate:—

TABLE II.

Dilute sulphuric anhydride,	1 c.c.	will	precipitate	0·231 grm.	Ba
Barium chloride,	"	"	"	0·032 "	SO_3
Disodic orthophosphate	"	"	"	0·011 "	Mg_2O
Magnesia mixture,	"	"	"	0·024 "	P_2O_5
Ammonic molybdate,	"	"	"	0·001 "	P_2O_5
Ammonic oxalate,	"	"	"	0·016 "	Ca_2O
Argentic nitrate,	"	"	"	0·010 "	Cl

Example No. 1.—Analysis of Fine Iron Wire.

Determination of Fe.—Weigh out from 0·3 to 0·5 grm. of the wire (previously rubbed bright with sand-paper). Throw into a large covered beaker, add about 20 c.c. concentrated hydrochloric acid and heat until solution. Then add about 5 c.c. concentrated nitric acid, heat until the colour becomes a deep orange. The solution often becomes previously coloured to a brownish black, from the solution of nitric peroxide in protochloride of iron, but this is removed by longer boiling, and the orange colour finally appears. Rinse off the convex cover, dilute largely, add ammonia in excess, heat to boiling, allow to settle, pass the clear supernatant fluid through a five-inch filter, and wash by decantation several times, boiling the precipitate with distilled water. Finally throw on the filter and wash with boiling water, until a few drops of the filtrate, caught in a test-tube, and acidified with dilute nitric acid, give no reaction for chlorine on addition of a little argentic nitrate. Dry thoroughly, empty the precipitate into a weighed crucible, burn the filter completely on a platinum wire, and add the ashes to the crucible; ignite at first very slowly, and finally very strongly; cool in desiccator, and weigh. Repeat this ignition until the weight remains constant (within one milligramme). To determine the amount of silica in this precipitate derived from the glass beaker, empty the ignited precipitate into a small flask, add 10 c.c. concentrated hydrochloric acid, boil until solution, empty into a casserole, evaporate to dryness, again dissolve in concentrated hydrochloric acid, dilute, filter through a three-inch filter, dry, ignite in a weighed crucible, and weigh. This weight of silica thus found, corrected for the silica of the two filter ashes, is deducted from the previous amount; and, from the weight of Fe_2O_3 thus found, the weight and the percentage of Fe are readily calculated.

Example No. 2.—Analysis of Magnesic Sulphate.*

A. *Determination of* MgO.—Dissolve 1 to 1·5 grms. in cold water, and add one-fifth its volume of ammonium chloride and sufficient disodic orthosphosphate (see Table II.) Be careful not to rub the side of the beaker with the stirring-rod. Cover, and set aside twelve hours. Filter and wash with cold water, to which one-quarter its volume of ammonia has been added, until the filtrate, on being tested for chlorine with argentic nitrate, gives only a slight opacity. Dry and ignite as usual to constant weight. If the precipitate or ash is not perfectly white, moisten with a drop or two of concentrated nitric acid, evaporate and ignite cautiously, and repeat this operation to a constant weight. Result, $Mg_2P_2O_7$.

B. *Determination of* SO_3.—Dissolve 1 to 1·5 grms. in water, acidulate with hydrochloric acid, dilute largely, boil, add barium chloride in slight excess (Table II.); heat for a few minutes, allow to settle, and decant the clear liquid on a filter. Wash several times by decantation with boiling water; throw on the filter, wash thoroughly, dry, and ignite. Empty into a small beaker, digest with very dilute hydrochloric acid, filter, wash thoroughly, dry, and ignite. Result, $BaSO_4$.

C. *Determination of* H_2O.—In a weighed porcelain crucible weigh out 1 to 1·5 grms. Heat very gently at first over a low flame, to avoid loss by the ebullition of the salt, and finally lower the crucible until about an inch above the extremity of the flame. After heating thus about an hour, weigh, and repeat the operation until the weight remains constant. A portion of the acid may be expelled if the temperature is too high.

Example No. 3.—Analysis of Barium Chloride.

A. *Determination of* Ba.—Dissolve 1 to 1·5 grms. in water, acidulate with hydrochloric acid, dilute largely, heat to boiling, add dilute sulphuric anhydride in sufficient excess (Table II.), and continue as in Example No. 2, B. Result, $BaSO_4$.

* In order to make the student entirely dependent for accuracy upon his own skill and care, the substance given out for analysis in this and all subsequent cases is intermixed with known proportions (in several varieties) of certain inert salts, &c. So that while none of the determinations are affected by this intermixture, the student is entirely unaware of the percentages to be found.

B. *Determination of* Cl.—Dissolve 1 to 1·5 grms. in cold water; acidulate with nitric acid; add argentic nitrate in sufficient excess (Table II.); stir well; warm gently until the precipitate has completely settled; wash thoroughly with boiling water acidulated with nitric acid, at first by decantation, and afterward on a filter; and dry. Remove the precipitate as completely as possible to a weighed porcelain crucible, brushing the paper with a feather. Burn the filter on the cover and empty the ashes into the crucible. Moisten the whole with a few drops of concentrated nitric acid; digest 5 to 10 minutes; add 2 or 3 drops of concentrated hydrochloric acid; evaporate cautiously, and fuse at as low a temperature as possible. Result, AgCl.

C. *Determination of* H_2O.—Heat 1 to 1·5 grms. in weighed porcelain crucible, exactly as in No. 2, C. A portion of the chlorine may be expelled if the temperature is too high.

Example No. 4.—Analysis of Cupric Sulphate.

A. *Determination of* CuO.—Dissolve 1 to 1·5 grms. in a porcelain casserole, dilute, heat to boiling, add pure potassic hydrate to an alkaline reaction, and boil until the precipitate settles readily on the removal of the gas flame. Decant rapidly the clear fluid through a filter; wash two or three times by decantation with boiling water; transfer to the filter, removing as completely as possible from the casserole; wash thoroughly and dry. Empty the precipitate as completely as possible into a weighed porcelain crucible, burn the filter on the cover, empty the ashes into the crucible, and ignite strongly. As a trace of the precipitate generally adheres so firmly to the casserole that it cannot be rubbed off, dissolve it now in a drop or two of warm dilute nitric acid, and moisten the whole precipitate and filter ashes in the crucible (which may contain a little reduced copper), with this solution, and again evaporate and ignite cautiously, and at last strongly, to a constant weight. In this precipitate determine the silica derived from the casserole exactly as in Example No. 1. Result, CuO.

Concentrate the filtrate and washings from the original precipitate of hydrated oxide of copper, acidify with hydrochloric acid, and test with sulphuretted hydrogen water.

B. *Determination of* SO_3.—Proceed exactly as in Example No. 2, B.

C. *Determination of* H_2O.—Heat 1 to 1·5 grms. in a weighed porcelain crucible at 140° C., until the weight remains constant. Loss = 4 equivalents of water.

Heat again over the flame, as in Example No. 2, C, until the salt becomes white and the weight remains constant. Second loss = last equivalent of water. If the temperature be too high during the last heating a portion of the acid may be expelled: in which case a dark tinge, due to CuO, may be observed near the sides and bottom of the crucible.

Example No. 5.—Analysis of Silver Coin.

Clean with potassic hydrate, wash, dry, and weigh.

A. *Determination of* Au.—Dissolve in a little pure concentrated nitric acid, dilute, filter, wash thoroughly, dry, ignite in a porcelain crucible, and weigh. Result, Au + AgS. Wrap in a little pure silver, heat in cupel to fusion, cool, dissolve in nitric acid, filter, wash, dry, ignite, and weigh. Result, Au.

B. *Determination of* Ag.—Heat the first filtrate to boiling, add dilute hydrochloric acid in excess, and continue as in Example No. 3, B. Result, AgCl.

C. *Determination of* Pb.—To filtrate from B add 10 c.c. dilute sulphuric anhydride, evaporate to dryness, dissolve in warm water, filter, wash, dry, ignite in a porcelain crucible, and weigh. Result, $PbSO_4$.

D. *Determination of* Cu.—Heat to boiling the filtrate from C. in a casserole, add pure potassic hydrate in excess, and continue exactly as in Example No. 4, A. Result, CuO.—*American Chemist.*

THE NATURE OF DIFFERENT GUMS.

DR. SACC, of Neuenberg, Switzerland, has made an extensive inquiry into the nature of different resins. We condense from it the following results:—The resins spoken of are copal, amber, dammar, common resin, shellac, elemi, sandarach, mastic, and Caramba wax. All these resins can be reduced to powder.

The following will become pasty before melting:—Amber, shellac, elemi, sandarach, and mastic; the others will become liquid at once.

In boiling water, Caramba wax will melt; common resin will form a semi-fluid mass; dammar, shellac, elemi, and mastic will become sticky; while copal, amber, and sandarach will remain unchanged.

Dammar and amber do not dissolve in alcohol; copal becomes pasty; elemi and Caramba wax dissolve with difficulty; while resin, shellac, sandarach, and mastic dissolve easily.

Acetic acid makes common resin swell; on all the others it has no effect.

Caustic soda dissolves shellac readily, resin partly; but has no influence on the others.

Amber and shellac do not dissolve in sulphide of carbon; copal becomes soft and expands; elemi, sandarach, mastic, and Caramba wax dissolve slowly; while resin and dammar dissolve easily.

Oil of turpentine dissolves neither amber nor shellac, but swells copal; dissolves dammar, resin, elemi, sandarach, and Caramba wax easily, and mastic very easily.

Boiling linseed oil has no effect on copal, amber, and Caramba wax; shellac, elemi, and sandarach dissolve in it slowly, while dammar, resin, and mastic dissolve easily.

Benzol does not dissolve copal, amber, and shellac, but does elemi and sandarach to a limited extent, and Caramba wax more easily; while dammar, resin, and mastic offer no difficulty.

Petroleum ether has no effect on copal, amber, and shellac; it is a poor solvent for resin, elemi, sandarach, and Caramba wax, and a good one for dammar and mastic.

Concentrated sulphuric acid is indifferent to Caramba wax; it dissolves all resins, imparting to them a dark brown colour, excepting dammar, which takes a brilliant red tint.

Nitric acid imparts to Caramba wax a straw colour; to elemi, a dirty yellow; to mastic and sandarach, a light brown; it does not affect the others.

Ammonia is indifferent to amber, dammar, shellac, elemi, and Caramba wax; copal, sandarach, and mastic become soft, and finally dissolve; while resin will dissolve at once.

It is not difficult, by means of these reactions, to test the different resins for their purity.—*Dingler, Polytech. Journal.*

ON THE EMPLOYMENT OF POTASSIUM FERRICYANIDE AS A TEST FOR COBALT, NICKEL, AND MANGANESE.

By ALFRED H. ALLEN, F.C.S.

IN a former number of the CHEMICAL NEWS a correspondent called attention to the possibility of distinguishing cobalt from nickel by potassium ferricyanide, which he directed to be added to a solution of the metal after addition of tartaric acid and excess of ammonia. My former pupil, Mr. J. Spear Parker, while in my laboratory showed that the tartaric acid might be replaced by citric acid, or omitted altogether, any ammoniacal salt answering the purpose. Cobalt occasioned a deep red colouration, while with nickel no change occurred if sufficient ammonium chloride

were present. The reaction is delicate and trustworthy. I find, however, that a solution of nickel to which ammonium chloride, ammonia, and excess of potassium ferricyanide have been added, becomes turbid on boiling, and in a short time deposits the whole of the nickel as a copper red precipitate, which often adheres to the sides of the vessel. Thus the presence of nickel is readily detected by a simple test, which answers perfectly well even in the presence of a large excess of cobalt,—the latter metal being indicated at the same time by the red colour of the solution.

The red precipitate I at first supposed to be nickel ferricyanide, and to have the same composition as the gelatinous reddish brown precipitate produced by potassium ferricyanide on addition to nickel nitrate. This was rendered the more probable from a similarity of decomposition by boiling with sodium hydrate, which readily converts the nickel into a black precipitate (probably Ni_2O_3) with production of sodium ferro- and ferricyanides.

The brick-red precipitate does not contain sufficient nickel to correspond to either $Ni_2''(C6N_6Fe)''''$, or $Ni_3''(C_6N_6Fe)_2'''$, and it evolves ammonia during the action of the soda.

I intend to examine this precipitate further, and to try and utilise it for the quantitative estimation of nickel, as whatever its composition may be, it is easily produced, easily washed, and readily decomposed into a definite compound by alkalies.

When a solution of manganous sulphate is treated with ammonium chloride and ammonia, and potassium ferricyanide gradually added to the solution so obtained, a whitish precipitate is first formed, which changes with the addition of more ferricyanide to a dark brown colour. This reaction is used in my laboratory to distinguish manganese from cobalt and nickel. The solution filtered from the precipitate contains ferrocyanide and ferricyanide, thus proving that the manganese has suffered oxidation at the expense of the ferricyanide. It is absolutely free from manganese, no green colour being developed by evaporation and fusion with alkaline carbonate and nitre. If the precipitate be boiled in the liquid containing excess of potassium ferricyanide, and then filtered from the solution, it is found to consist of a mixture of a higher oxide of manganese with manganous ferrocyanide; it yields by boiling with sodium hydrate, a black oxide of manganese and sodium ferrocyanide. The oxide of manganese thus obtained is entirely soluble in hot dilute HCl, with evolution of chlorine. There is a process described in the last edition of Fresenius where manganese is estimated by boiling the solution, in presence of iron, with potash and potassium ferricyanide, and then estimating the resultant ferrocyanide by standard permanganate.

I have employed the reaction of ferricyanide with an ammoniacal solution of manganese for the quantitative estimation of the metal, but do not think it possesses any advantage over the precipitation by bromine, if it be as good.

Manganese kept in solution by means of tartaric acid gives a similar reaction to the ammonium chloride solution, but the precipitation does not occur completely until the liquid is boiled.

In my practice it is frequently required to estimate the *real* manganese present in manganese ores—not the chlorine producing power—and also in spiegeleisens, &c., and this is often a tedious process, as the iron has always to be first separated, and the manganese requires to be very accurately determined.

In the above reaction there seemed a means of throwing down the manganese completely even in presence of iron, without the latter metal going with it, and with this view I mixed manganous sulphate with ferric chloride, added ammonium chloride, tartaric acid, and excess of ammonia, and then potassium ferricyanide. The liquid was then boiled for some time, but without any precipitate being formed, so the presence of iron is apparently fatal to the process. With a smaller proportion of iron the manganese was partially precipitated, and the use of soda or potash instead of ammonia succeeded no better.

On treating a solution of zinc sulphate with excess of ammonium chloride and ammonia, and adding potassium ferricyanide, no change occurs either in the cold or on boiling, but if the heat be continued *very* long a slight white turbidity is occasioned, probably in consequence of the formation of a small quantity of ferrocyanide. On adding potassium ferrocyanide to either the hot or cold liquid, the zinc is thrown down as white zinc ferrocyanide, which is a far better and more delicate method of detecting it than the precipitation as sulphide.

Thus either one of the four metals, nickel, cobalt, manganese, or zinc can be readily distinguished from the others by adding first ammonium chloride and excess of ammonia, and then excess of potassium ferricyanide, when one of the following reactions will take place:—

(1). A brown precipitate = manganese.
(2). A deep red solution = cobalt.
(3). No change in the cold—a copper red precipitate on boiling = nickel.
(4). No change in either hot or cold liquid. Add potassium ferrocyanide—white precipitate = zinc.

As these four metals frequently occur in the same analytical "group," and in presence of ammoniacal salts, the above method of distinguishing them will, I think, be found useful, the only objection being that the explanations of the reactions are somewhat difficult, but I propose to study this question further.

I have not tried the reactions in the presence of any other metal except copper, which does *not* interfere with the test for nickel, and only by the colour with the reaction for cobalt.

The presence of manganese or zinc interferes with the tests for nickel and cobalt, which may prevent the reaction being used for the estimation of nickel in German silver, but I am still examining this question.

ON THE CAPABILITY OF CERTAIN SULPHIDES TO FORM THE NEGATIVE POLE OF A GALVANIC CIRCUIT OR BATTERY.*

By W. SKEY,
Analyst to the Geological Survey of New Zealand.

WHEN a piece of massive galena is placed in voltaic contact with amalgamated zinc, and immersed along with it in weak sulphuric acid, to within an inch or two of the point of contact, a galvanic current is at once established, gas in quantity being given off at the surfaces of the galena, while the zinc is rapidly oxidised.

Three or four such pairs when connected among themselves, intensity fashion, afford a current of electricity strong enough to decompose acidulated water, and manifest all the phenomena of a small galvanic battery. Such an arrangement may properly be termed a *pyritous battery*—in accordance with the custom hitherto observed, of designating new forms of batteries after some distinguishing or novel feature in them.

Several other metallic sulphides manifest similar phenomena when coupled in this manner with zinc, amongst which are the following:—Zinc blende, copper pyrites, vitreous copper stibnite, proto-sulphide of iron, and the sulphides of silver, mercury, platinum, and gold.

The only sulphide I have yet found any difficulty with in setting up this action, under these conditions with zinc, is mundic, or the bi-sulphide of iron; but if the point of contact between it and the zinc is submerged in the acid, gas is evolved at this point, and the area of evolution rapidly spreads around from this, until the whole surface of the specimen becomes active.

* Read before the Wellington Philosophical Society.

The gas given off from the surfaces of these sulphides in the foregoing experiments was *sulphuretted hydrogen*. The effects, therefore, upon these sulphides when thus made to form the negative pole of a galvanic pair, is to desulphurise them; in some cases the ultimate effect is to reduce the metal to the metallic state. At any rate this obtains for the sulphides of mercury, lead, silver, platinum, and gold. With common yellow copper pyrites, a beautiful iridescence is communicated to it in a few seconds after the liberation of gas commences, owing, of course, to desulphurisation.

Saline solutions appear to produce the same effects in these instances as sulphuric acid, but they take place much slower.

The fact is thus directly established, that several of the metallic sulphides are capable of performing all the functions of the negative pole of a galvanic pair. From this, and the manner in which these sulphides have been connected with each other, it is clearly demonstrated that they are pretty good conductors of electricity. To a certain extent, indeed, all bodies are conductors of electricity, the terms conductor and non-conductor being only expressive, as Faraday affirms, "of extreme degrees of one common condition," there being no complete conductor, nor any absolute non-conductor; but these results show I think, these sulphides are conductors to a degree not before recognised—a circumstance which renders a comparison of their conducting power with that of other conductors necessary.

Indirectly it has appeared, that nascent hydrogen is able to decompose these sulphides at common temperatures, by combining directly with their sulphur, thus accomplishing at a low temperature that which would require a very high one, in case it (the hydrogen) were presented to the sulphide in its ordinary form.

In relation to the amalgamating processes used for the extraction of gold at our batteries, these results prove that zinc amalgam, in contact with acid solution, has precisely the same effect in decomposing the sulphides of gold, mercury, iron, &c., as sodium amalgam; like this amalgam, therefore, it keeps perfectly bright and mobile in presence of sulphides, or the products of their natural metamorphoses.

Whether or no such an amalgam could ever be profitably substituted for sodium amalgam in our gold batteries has yet to be determined. I am afraid that the continual addition of sulphuric acid to the water conveying the auriferous stuff to the plates, &c., which the use of this amalgam necessitates, would increase so much the cost of extraction as to render it unprofitable; still, as the water need only be very slightly acidified, it may be well to keep the fact thus arrived at in mind, when projecting intended improvements in the amalgamation of the gold from auriferous reefs.

In conclusion, I will only now remark, that the kind of phenomena just described appear to have some relation to the formation and decomposition of metalliferous lodes.

It is pretty certain, analogically considered,* that these sulphides should be able to form among themselves a series of voltaic pairs in presence of saline solutions, as they differ from each other in respect to their affinities for oxygen. Galena and copper pyrites, for instance, should form a voltaic pair, in which the galena would be the negative element; sulphide of silver and galena again should furnish another pair, in which the galena would have its function reversed, and so on for the rest, according to their relative proneness to change.

In a natural way, therefore, the contact of dissimilar sulphides generally should set up galvanic action and chemical decomposition. and by setting up this action, we might have a sulphide decomposed by saline solutions, which it would be able to resist if it stood alone; or, on the other hand, we might have an easily decomposible sulphide preserved by the association with it of one still more ready to decompose.

* Since determined to be the case.

Since the results just detailed were arrived at, I have been referred by Dr. Hector to a paper by Mr. Robert Hunt, entitled, "Researches on the Influence of Magnetism and Voltaic Electricity on Crystallisation and Conditions of Matter," given in "Memoirs of Geological Survey of Great Britain," vol. i.

The subject of that paper is similar in part to this under consideration, but I do not see that the author has anticipated any portion of the results stated here; he certainly does not demonstrate the actual and continuous production of electricity by the contact of sulphides with positive bodies in saline solutions; nor does he show that copper pyrites conducts electricity, the water-line being, as you will observe by reference to his diagram 14, page 457, above the point of contact between the pyrites and the battery, so that the change or decomposition of the ore need not involve the necessity of conducting power in the pyrites, as in the case of that connected with the positive end of the battery, the conducting power necessary for this decomposition might well have progressed around, from this point or line of contact by the liberation of copper; while, in case of the other piece of pyrites, all the conducting power necessary for the production of the phenomena described may, with propriety, be referred to the wire bound around it.

I would also state, that in repeating this experiment of Mr. Hunt's I find that, different to his own observations as stated, both the pieces of pyrites are chemically affected, while it is not that in contact with the copper of the battery which displays such marked iridescence, but that communicating with the zinc; and it passes into this state, not by an oxidation process, but by a desulphurising one, brought about by the liberation of hydrogen upon its surfaces; this gas, when freshly liberated, having a desulphurising effect upon sulphides generally, as I have clearly shown above.

PRELIMINARY NOTICE ON THE AMIDO-DERIVATIVES OF ORCIN.

By JOHN STENHOUSE, LL.D., F.R.S.

In a paper I published on March 1st, 1871,* I mentioned that I had made some experiments on the action of reducing agents on trinitro-orcinic acid and trinitro-resorcinic acid, but as Dr. Schreder has recently announced† that trinitro-resorcinic acid is identical with oxypicric or styphnic acid, and has investigated the amido-derivatives of it, I have not pursued my investigations farther in that direction, but have confined them to trinitro-orcinic acid.

Triamido-orcin, $C_7H_5(NH_2)_3O_2$.—When trinitro-orcinic acid is treated with reducing agents the NO_2 is replaced by amidogen, giving rise to amido-compounds. For the production of the triamido-orcin I find sodium amalgam to be the best reagent; as when nitro-orcin is agitated with water and sodium amalgam it rapidly becomes brown and ultimately colourless, giving rise to the triamido-orcin. The same substance is formed when trinitro-orcin is boiled with tin and hydrochloric acid, or with zinc and dilute hydrochloric acid. Intermediate amido-compounds appear to be formed, but I have not yet succeeded in isolating them.

Amido-diimido-orcin, $C_7H_5(NH_2)(NH)_2O_2$.—This substance is formed by the oxidation of triamido-orcin. When the colourless alkaline solution of triamido-orcin, obtained by treating nitro-orcin with sodium amalgam in the way already mentioned, is exposed to the air, it rapidly absorbs oxygen and acquires a magnificent blue colour, due to the formation of amido-diimido-orcin. The addition of an excess of sulphuric acid to this solution precipitates the

* *Proc. Roy. Soc.*, vol. xix., p. 410. Preliminary notice, CHEMICAL NEWS, vol. xxii., p. 98.

† *Ann. Chem. Pharm.*, vol. clviii., p. 244.

amido-diimido-orcin sulphate in dark purple brilliant scales, which can be obtained of great beauty by re-crystallisation from water, in which they are but slightly soluble. The addition of an acid renders them still more insoluble. By substituting hydrochloric acid for sulphuric acid in precipitating the blue solution the *amido-diimido-orcin hydrochlorate* is obtained in thin silky needles of a dark brown colour, which are much more soluble in water than the corresponding sulphate. The *nitrate* forms purple scales much resembling the sulphate, but more soluble, and is readily decomposed by excess of nitric acid. The *oxalate* is but slightly soluble, and crystallises in purple scales. The *picrate* forms iridescent green needles and plates, which are but slightly soluble. The *acetate* is much more soluble. The base itself, *amido-diimido-orcin*, can be obtained by treating the hydrochlorate with ammonia, or by exactly neutralising the blue alkaline solution before mentioned with hydrochloric acid, when the base separates in opaque needles having a green iridescent lustre. The base is but slightly soluble in dilute ammonia, and almost insoluble in water, but it dissolves readily in solution of sodic hydrate, with a fine deep blue colour, which gradually disappears on boiling, ammonia being evolved at the same time.

Nitric acid acts readily upon amido-diimido-orcin, forming an acid which gives crystalline salts the nature of which I have not yet determined.

A NEW METHOD FOR THE DETERMINATION OF AVAILABLE CHLORINE IN "BLEACHING POWDER."

By J. B. F. HERRESHOFF,
Assistant in Brown University Laboratory, Providence, R.I.

HAVING had occasion to estimate the available chlorine in several samples of bleaching powder, and finding the methods now in general use inconvenient, and, unless executed with the utmost care, liable to much inaccuracy, I have of late devised a method which for accuracy, ease of execution, convenience, and economy of time, surpasses those in present use.

It is based upon the fact that when "bleaching powder" is made to act on an excess of stannous chloride in strongly acid solution, stannic chloride is formed at the expense of all available chlorine in the former. The reaction is represented by the following:—

$$[CaCl_2O_2+CaCl_2]+4HCl+2SnCl_2=2CaCl_2+2H_2O+2SnCl_4.$$

Any excess of stannous chloride now remaining in solution is estimated by means of a standard solution of potassic dichromate, and, deducted from the former amount used, gives the weight of stannous chloride changed into stannic chloride by the "bleaching powder" used. The following represents the reaction:—

$$3SnCl_2+K_2Cr_2O_7+14HCl=3SnCl_4+2KCl+Cr_2Cl_6+7H_2O.$$

The process is conducted in the following manner:—

Weigh accurately 13·8738 grms. of pure potassic dichromate, dissolve in water, and dilute the solution to one litre. Each cubic centimetre of this solution has oxidising power equivalent to 0·01 milligrm. of chlorine.

Weigh about 30 grms. of stannous chloride and dissolve in water, to which chlorhydric acid is freely added, and dilute the solution to one litre.

Fill two burettes with these solutions, run off about 10 c.c. of the stannous solution, dilute somewhat with water, and add about 5 c.c. of chlorhydric acid and a few drops of solution of starch, and potassic iodide. Now run in the solution of potassic dichromate, until a last drop gives to the solution a blue colour.

If it requires 20 c.c. of the standard dichromate solution, then 1 c.c. of the stannous solution will equal 2 c.c. of the former, and also 0·02 milligrm. of chlorine.

Again, supposing the tin solution to be of the above strength, measure off 20 c.c. of the now standardised tin solution, dilute with water, as before, and add 1 grm. of the "bleaching powder" in question, well triturated with water, and then 10 or 12 c.c. of chlorhydric acid.

The reaction is energetic and complete, and, if sufficient amount of chlorhydric is introduced, the solution will become perfectly clear.

Add a few drops of solution of starch and potassic iodide, and then run in the potassic dichromate solution until the deep blue colour of iodide of starch remains permanent. Supposing 10 c.c. are required, then 10 c.c. + 2 c.c. = 5 c.c.; 20 c.c. − 5 c.c. = 15 c.c. As 1 c.c. of the stannous solution equals 0·02 Cl and 15 c.c. are required for 1 grm. of the "bleaching powder," then $15 \times 0{\cdot}02Cl = 0{\cdot}30Cl$, or 30 per cent.

Penot's arsenic method, the one now in general use, has disadvantages.

Arsenious acid is with difficulty purified, and there is no convenient method by which to test its purity.

The standard solution of sodic arsenite is tedious to prepare, from the fact that it requires a long time for complete solution of the required amount of arsenic in sodic carbonate solution.

This solution will not keep with certainty for any length of time unchanged, and is newly standardised only with difficulty, which arises from the fact that trouble is experienced in preparing perfectly pure iodine, caused mainly by its property of retaining moisture, and its volatility. This latter property is a source of much injury to the balance on which it is weighed, unless conducted in a closed vessel.

If the solution of iodine be of the correct standard no trouble is experienced in accurately standardising the arsenious solution, provided the iodine solution be run into the latter, in which starch and an excess of sodic carbonate is present.

One great advantage in favour of the new method is that the standard potassic dichromate solution will remain for any length of time unchanged, and although the tin solution undergoes change, yet it is a matter of only a few moments to accurately re-standardise it by means of the dichromate solution.

The correctness of the results obtained by this method will be seen to depend upon the purity of potassic dichromate—a substance, though not always to be found of perfect purity, yet the impurities, which consist mainly of potassic sulphate, are so small as not to materially affect the final results.

This method gives accurately corresponding results. In four analyses made on a sample of "bleaching powder," the following results were obtained:—

	Cl.
1	26·42 per cent.
2	26·50 " "
3	26·56 " "
4	26·48 " "

—*American Chemist.*

ON THE ACTION OF SULPHUROUS ACID ON METALS.

By P. SCHWEITZER, Ph.D.

Zinc and Sulphurous Acid.—If we dissolve metallic zinc by means of a mineral acid, and add a few drops of a solution of sulphurous acid, we observe, according to the strength of the sulphurous and hydrochloric acid per cent, a more or less rapid separation of sulphur and development of the odour of sulphuretted hydrogen gas. This is a reaction we resort to daily in our laboratories for the detection of sulphurous acid in hydrochloric, acetic, and other acids, and is so delicate a test for the presence of

this impurity, that the minutest traces of it may be discovered in this way without difficulty.

The reaction according to which this decomposition takes place is exceedingly complicated, and we look in vain to any of our text-books for information. Many false statements, too, will be encountered on the subject, which only a close study will reveal as such. In the following will be found the results of some experiments, undertaken with a view of settling this question :—

A strong solution of sulphurous acid was prepared, so as to be perfectly free from sulphuric acid, sulphuretted hydrogen gas, free sulphur, and oxygen, which, by the way, requires a great deal of care. In this acid, care being taken to exclude all atmospheric air, pure zinc was dissolved. No generation of gas could be observed, and the fluid, after deepening gradually in colour so as to become at last quite brown, like old sulphide of ammonium, commenced to separate sulphur, regaining its original colourless state after some time.*

While brown, and before sulphur had commenced to separate, part of the fluid was saturated with caustic potassa and tested for sulphur (as sulphide of potassium with nitroprusside of sodium), which was proved to be absent. After repeatedly shaking the fluid, which had become milky from separated sulphur, the solution itself being quite colourless, and allowing it to stand for several hours, a small amount of it was taken and tested in several ways. It contained still an excess of sulphurous acid, which, I may mention here, does not disappear even after standing for several weeks with metallic zinc, owing to the zinc becoming covered with a coating of sulphide of zinc, a trifling amount of which is always formed in this operation; part of it may be seen floating about in the liquid. Upon acidulating a part of the solution in question with hydrochloric acid and heating, sulphur separated in large quantities and of a yellow colour, while sulphurous acid was given off; another portion was acidulated with the same acid and left standing; in a few minutes sulphur separated, increasing in quantity while standing, and sulphurous acid being given off again. This established the presence of hyposulphurous acid, as no other known acid of sulphur is decomposed in the cold by a mineral acid into sulphur and sulphurous acid. Another portion of the fluid was then taken, diluted with water, acidulated with hydrochloric acid, and chloride of barium added. No precipitate whatever formed, proving the absence of sulphuric acid. This test has to be done quite rapidly, as after a few seconds sulphur begins to be separated, recognisable when in small quantity by the peculiar opalescent appearance it presents. A third portion of the fluid was acidulated with hydrochloric acid, boiled so as to decompose all polysulphur acids, which in the case of hyposulphurous acid cannot be accomplished in less time than two or three weeks. As the precipitated sulphur does not settle very quickly, the fluid was shaken with a small piece of bright metallic copper which rendered it clear almost immediately, so that it could be filtered and tested for sulphuric acid. A heavy precipitate was obtained with chloride of barium, proving the presence of this acid in large quantity and beyond doubt. This sulphuric acid, though not present in the original fluid, was produced therefore by the decomposition of a sulphur acid, and judging from the synthesis of these acids, this must have been trithionic acid.

$$2S_2O_2+3SO_2=2S_3O_5+S \text{ (preparation).}$$
$$S_3O_5=SO_3+SO_2+S \text{ (decomposition).}$$

We have therefore present in the fluid, after acting with sulphurous acid on metallic zinc, SO_2, S_2O_2, S_3O_5, S, ZnO, ZnS, a trace. I may mention here that a solution of hyposulphite of soda treated with sulphurous acid turns, especially upon heating, first yellow, then brown, sulphur separates, and trithionic acid is formed. The change of colour in the original experiments therefore indicates the point when trithionic acid is beginning to be formed. The reaction may be represented in the following way :—

(1). $2Zn+3O_2=ZnO,SO_2+ZnO,S_2O_2$.
(2). $2S_2O_2+3SO_2=2S_3O_5+S$.
(3). $SO_2+S=S_2O_2$.
(4). $5SO_2+S=2S_3O_5$.

The result being $ZnO.SO_2$; $ZnO.S_2O_2$; $ZnO.S_3O_5$; besides sulphur, sulphide of zinc, and the undissolved metal. As regards the reaction under 3, I am perfectly aware that sulphur under ordinary conditions does unite with sulphurous acid, but if separated in the fluids containing it, its more active state may very likely favour such combination; the reaction under 4 is a fact, as it is a method for the preparation of S_3O_5.

This fluid does not contain tetra- or penta-thionic acid, for on saturating it with caustic potassa and dissolving by an excess of alkali the first precipitated oxide of zinc, no sulphur separated to form sulphide of potassium on boiling. Both of these acids are decomposed, by boiling with alkalies, into sulphur and trithionic acid; this latter being decomposed in its turn again, but very much slower, into sulphurous and hyposulphurous acids.

Upon treating now sulphurous acid with metallic zinc in the presence of hydrochloric acid, we obtain a milky liquid, and the odour of sulphuretted hydrogen becomes more or less perceptible. The reaction here is more rapid and complicated. Zinc and hydrochloric acid generate hydrogen, as is well known, and the question may arise whether the hydrogen, being in the nascent state, will directly reduce sulphurous acid to water and sulphuretted hydrogen gas. Many metals decompose water, oxide of the metal being formed, while hydrogen is set free. On filling a little flask with sulphurous acid solution, inverting it and letting its mouth dip under sulphurous acid, contained in a porcelain dish, and introducing into the flask a piece of sodium, a vivid separation of hydrogen took place, while the sulphurous acid remained clear, and no trace of hydrosulphuric acid could be detected in the escaping gas. The same was observed when a piece of aluminium was substituted, in which case the fluid had to be heated to accelerate decomposition. The nascent hydrogen here was therefore without action upon the sulphurous acid, and it is not likely that, in the case of zinc and hydrochloric acid, the hydrogen should reduce sulphurous acid to water and sulphuretted hydrogen gas.

However, another experiment was tried, the result of which presents a still stronger reason for not considering hydrogen the reducing agent of sulphurous acid. In treating sulphurous acid with zinc and hydrochloric acid in the cold, until the reaction ceased, freeing the sulphur from the liquid in the way indicated, and adding to it more hydrochloric acid, and heating, a precipitate of sulphur was obtained, indicative of the presence of a polysulphur acid; but as no sulphuric acid could be found in the fluid, this must have been hyposulphurous acid. In order to succeed in this experiment much sulphurous and little hydrochloric acid must be taken; the separated sulphur there being also yellow. As therefore nascent hydrogen was without action upon sulphurous acid, but hyposulphurous acid and sulphur were separated, the probability is that sulphuretted hydrogen gas is formed by the direct combination of sulphur with hydrogen. In the moment of separation of both hydrogen as well as sulphur, we obtain all hydrogen and all sulphur as sulphuretted

* The few bubbles of gas escaping at the beginning are very probably carbonic acid. Zinc, like many other metals, oxidises in moist air, becoming thereby converted into basic carbonate. A stick of zinc, which had been cleaned beforehand with a file, so as to present a pure metallic surface, did not show the phenomenon of generating gas. Ordinary granulated zinc (which is always coated with a whitish oxycarbonate) shaken with water imparts to it an alkaline reaction, on account of the carbonate dissolving to a perceptible extent, and which may be easily tested with solution of cochineal. The amount of carbonic acid which all metals absorb, when exposed to the oxidising influence of moist air, is accounted for by the fact that it dissolves to a much larger extent in moist air than would correspond to 1·25 of a per cent, and that it very likely exists in this solution as carbonic acid and not as anhydride.

hydrogen; so in the case of treating sulphide of sodium with an acid.

$$Fe+HCl=FeCl+H.$$
$$FeS+HCl=FeCl+HS.$$
$$Fe+HSO_4=FeSO_4+H.$$
$$FeS+HSO_4=FeSO_4+HS.$$

But even one of these two elements, while in the nascent state, will combine with the other. We know that nascent hydrogen will combine directly with phosphorus, forming phosphuretted hydrogen; and, though sulphur, presenting so many strange and peculiar anomalies in its different states, may not unite as flowers of sulphur with hydrogen, it is very likely that sulphur, just separated from the decomposing hyposulphurous acid, will form sulphuretted gas, with nascent hydrogen. The sulphur certainly must have retained in this case some active principle, as it will directly combine upon shaking with metallic copper, and, as we will see hereafter, readily with metallic cadmium. Besides, sulphuretted hydrogen gas is only perceived in this reaction after sulphur has commenced to separate.

Cadmium and Sulphurous Acid.—In treating a piece of metallic cadmium, which had been rolled out to a very thin and long strip, with the same sulphurous acid, the reaction took place in a similar way as that with zinc. The fluid turned first yellow, but still remained clear, which required, however, a much longer time than with zinc, then darkened, separated a little white sulphur, and precipitated finally a large amount of sulphide of cadmium. This is insoluble in weak sulphurous acid, and therefore precipitated, while sulphide of zinc, being soluble, is consequently prevented from forming. We have a clear case here of separating sulphur combining directly with a metal. But this separating sulphur seems to have even the power of depriving salts like sulphide or hyposulphite of cadmium of its metal, forming thereby sulphide of cadmium and sulphuric acid. For while in the liquid resulting from the action of sulphurous acid upon cadmium, and which has been in contact with the metal for only three or four hours, no sulphuric acid can be detected before boiling, its quantity will be perceptible after standing in contact three or four days, and will increase by standing several weeks. This sulphuric acid derives its origin from the oxidation of the sulphurous acid by the oxygen of the metallic oxide, which is decomposed by the separating sulphur, The experiment can be easily made by adding a solution of either nitrate or sulphate of cadmium to hyposulphite of soda. Upon boiling, a slight opalescence only will be observed, as cadmium salts are generally acid, but no precipitate of either sulphur or sulphide of cadmium. Upon adding, however, a little hydrochloric acid, a heavy precipitate of sulphide of cadmium will be obtained immediately. The sulphur, therefore, from the decomposition of the hyposulphurous acid, was decidedly active.

The original fluid treated in the same way, viz., boiling with a little hydrochloric acid, immediately gave a precipitate of sulphide of cadmium. Before, however, any marked precipitate of CdS was observed, and after the fluid had remained in contact with the cadmium for about four hours, no sulphuric acid was found to be present, as has been already mentioned. Upon acidulating and boiling this solution, filtering out the separated sulphur, and testing the filtrate, much sulphuric acid was found, originating, as in the case of zinc, from the decomposition of S_3O_5. The total reaction may be thus expressed:—

$$2Cd+3SO_2=CdO.SO_2+CdO.S_2O_2.$$
$$2S_2O_2+3SO_2=2S_3O_5+S.$$
$$(SO_2+S=S_2O_2).$$
$$(5SO_2+S=2S_3O_5).$$
$$Cd+S=CdS.$$
$$CdO.SO_2+S=CdS+SO_3.$$

It is hardly necessary to say that the sulphuric acid will combine with oxide of cadmium, liberating either SO_2 or S_2O_2. The fluid, after a sufficient length of time, will therefore contain CdO,SO_3; CdO,SO_2; CdO,S_2O_3; CdO,S_3O_5; CdS; and the undissolved metal. All sulphur will have disappeared, and entered into combination with cadmium, so that a portion of the fluid, turbid and yellow from suspended sulphide of cadmium, will become clear upon acidulating with hydrochloric acid; no odour of sulphuretted hydrogen will make its appearance, as it is decomposed by the sulphurous acid. After filtering and washing, the precipitate, may, however, be readily recognised as CdS.

Nickel and Sulphurous Acid.—Nickel in form of the well-known cubes was treated with sulphurous acid in a bottle; the action proceeded similarly to that of the two former metals, but was very much slower even than that of cadmium. After several hours a darkening and green colouration of the fluid occurred, but a day elapsed before a separation of sulphur took place, and then only small specks of it were seen floating about. In this stage of the operation the fluid contained NiO,SO_2; NiO,S_2O_2; some sulphur, but no S_3O_5 or SO_3. After several weeks' standing all sulphur had disappeared and combined with nickel as NiS, which in this case was certainly formed directly from the metal, as it presented the appearance of a black, heavy, scaly mass; this mass amounted to a considerable quantity, much more than could have formed from the little precipitated sulphur, and as much sulphuric acid was then to be found in the solution, we must conclude that either hyposulphite of nickel is not decomposed by sulphurous acid like the cadmium or zinc salt, but, under the influence and in contact with the metal and sulphurous acid, is converted into sulphuric acid, separating thereby sulphur, which combines with the nickel, thus:—

$$2(NiO.S_2O_2)+SO_2=2(NiO.SO_3)+3S;$$

or we have to admit a secondary reaction of the sulphurous acid upon the metallic nickel, thus:—

$$2Ni+2(SO_2)=NiO.SO_3+NiS.$$

I should decidedly favour the former view, which does not appear to be so very strange, if we remember that sulphurous and hyposulphurous acids are decomposed differently when combined with different oxides. I only recall the preparation of thithionic acid either from bisulphite of potassa with flowers of sulphur, or from hyposulphite of potassa by sulphurous acid. We do not get trithionic acid if we take in these cases soda instead of potassa salts.

However, we have in the fluid, after allowing the reaction to proceed for a considerable length of time, NiO,SO_3; NiO,SO_2; NiO,S_2O_2; NiS.

Aluminium and Magnesium with Sulphurous Acid.—These two metals dissolve readily, the first in cold, the second in hot sulphurous acid. No sulphur is separated in the fluid, and no sulphuretted hydrogen gas is observed, as has been already mentioned. But upon analysing the clear solution, we find in both cases SO_2; SO_3; S_3O_5; S_2O_2.

The presence of SO_3 and S_3O_5, and the non-appearance of S, forces us to admit two or three reactions taking place simultaneously and independently of each other. The first, the solution of the metal by decomposing water, liberating hydrogen, and dissolving as oxide in the sulphurous acid; the second, the action of sulphurous acid upon the metal by forming a sulphide and hyposulphite; and the third, by forming a sulphate, hyposulphite, and trithionate.

(1). $Mg+HO+SO_2=MgO.SO_2+H.$
(2). $2Mg+3SO_2=MgO.SO_2+MgO.S_2O_2.$
(3). $4Mg+8SO_2=MgO.SO_3+MgO.S_3O_5+2(MgO.S_2O_2).$

These reactions seem to take place according to concentration, and depending in general upon conditions, which a future and closer study may reveal, and in the investigation of which, I hope, other chemists will participate.—*American Chemist.*

ON COLOURS FROM COAL-TAR.*

By HARRY N. DRAPER, F.G.S.

A FEW evenings since, when I was thinking how I might best place before you this subject of Colours from Coal-Tar in an instructive, and at the same time, if possible, an interesting manner, I chanced, in a very charming book, upon a passage which, with your permission, I will read to you.

"Yesterday forenoon, writes a friend, I went to the South Kensington Museum. It is really an absurd collection—a great deal of valuable material, and a great deal of perfect rubbish. The analyses are even worse than I was led to suppose. There is an *analysis of a man*. First a man contains so much albumen, and there is the albumen; so much phosphate of lime, fat, hæmatin, fibrine, salt, &c., &c.; then in the next case, so much carbon, so much phosphorus, a bottle with sticks of phosphorus, so much potassium; and there is a bottle with potassium, calcium, &c. They have not bottles of oxygen, hydrogen, and chlorine, but they have cubical pieces of wood on which is written, 'The quantity of oxygen in the human body would occupy the space of 170 cubes of the size of this.' What earthly good can this do any one?"—BROWN, *Horæ Subsecivæ*.

Now, when I tell you that, did I not stand in such close proximity to the admirable museum of this Society, and in awe of the unfavourable opinion of some friends of mine whom I see here, and whose opinion I respect, I should be much disposed to say "that, very little good indeed;" you will understand that it is not without diffidence that I ask your attention to the somewhat formidable array of specimens which you see upon the table, or to the diagrams which hang against the wall. It is not that I have large sympathies with those, who, thinking the best part of a scientific lecture to be the experimental one, are ever on the alert for brilliant coruscations of light, and for explosions, but that I realise most fully the great difficulty of conveying anything like an accurate idea of complex chemical changes, with the opportunities and within the limits of a single lecture; and when we have, too, in the same hour, to occupy ourselves with the practical results of an important industry like this. However, as I have introduced the diagrams to your notice, it is but fair that I should be their apologist; and while, I think, I may say that they need not be a cause of uneasiness to us, I hope that when (as is but too probable) I come to use hard words, they will be a positive help, and give us some notion of what the hard words mean. And, as regards the specimens, I think when I say that each of them represents a fact, and often a very beautiful fact in chemistry, that each one of them has its own peculiar application in the arts or manufactures, and that they are, without exception, products of that wonderful fossil flora which we call Coal, you may be disposed to view them indulgently. I shall hope, too, to give them new interest in your eyes as we proceed; and it will be well if, at the outset, we get a clear idea of the object before us. We propose to trace the *useful*, as represented by this black, unsightly coal, in its progress towards the *beautiful*, as exemplified by the brilliant dyes with which we have been familiar during the past fourteen years. The mind, even when accustomed to chemical changes, and trained by experience to expect what would otherwise be startling results, does not easily grasp the conception that the millions of tons of coal which, in these islands, await the hands of the miner, represent a vast magazine, not only of light and heat, but of colour-giving substances, which vie in splendour with the tints of the most gorgeous exotics or the varied plumage of tropical birds.

The connection of colour with light is inseparable. We cannot imagine its independent existence. It is not only when, as you have seen in some of the earlier lectures of this course, a ray of light is intercepted by a prism, that its velocity is altered, and that magnificent spectrum whose tints never weary us extends itself upon the screen; but nearly all bodies in nature split up white light, and in effect these differ only from prisms in that they absorb some rays and reflect others. That this is so we know; but though we may scarcely adopt the fanciful hypothesis of Darwin, whose "Ethereal powers"

> "Cling round the aërial bow, with prisms bright,
> And, pleased, untwist the sevenfold threads of light;
> Eve's silken couch with gorgeous tints adorn,
> And fire the arrowy throne of rising morn,"

we really know little more than we might thus express, and cannot predict, either from the shape, physical condition, or chemical constitution of a body, whether it shall appear to our eyes red, yellow, or blue. But grant white light and anything which will absorb a part of it, and you have colour. But does light, upon which so marked a change is effected when this partial absorption takes place, itself effect no change when it is not partially but wholly absorbed by the bodies upon which it falls? All nature gives an affirmative reply. The snow-drop will flourish in the most secluded corner of the garden, and the wood-sorrel, we know, puts forth its pale blossoms in the shadiest dell; but it is in the full blaze of the tropical sunlight that cactus and aloë assume their vivid tints and the orchis takes its rainbow hues. Shall we, then, allow imagination too much rein if we think that centuries ago, when that which is now a coal-field was a waving forest, the light drunk in by every leaf did something more than clothe the copse in sombre green. May we not suppose that just as a logwood tree or an indigo plant of to-day returns in colouring matter the work done by the light it absorbs, these dark tracts of pines no less stored up their colour-giving substances but withheld them for a future age. And if we turn from the domain of fancy to that of fact, we see, as has been well pointed out by Hofmann, how much the practical science of to-day tends to turn to the vast storehouses of raw material which the mineral kingdom affords, and to form from inorganic bodies the most rare and costly products of organic life. Already, as he says, we have found the potash salts, which were hitherto obtained only from plants, in that great magazine of potash, the ocean; and paraffin and allied fatty bodies obtained from coal have already supplanted, to a very large extent, the fats and oils for which we were accustomed to look to animal and vegetable sources alone. So, in the same way, we have now some other things which, as flavours and perfumes, appeal to our senses of taste and smell, derived from mineral sources. It is not, then, after all, so very strange that we should seek and find *colour* in *coal*.

"Coal and Iron," it has been well said, "are kings of the earth;" and as we traverse to-day the desert of hard names and abstract fact which separates coal-tar from colour—a desert by the way in which there are a few pleasant oases—we shall do well to remember how much wealth from this source alone lies stored up in the coal-fields of Great Britain; and, perhaps, there are few cases we could select in which the contrast between the value of two substances is greater than it is between coal-tar and say, for example, purple dye; the first a fit type, if not of complete uselessness, at least of offensiveness; and the last so prized that a pound of wool dyed with the Tyrian purple, which, as we know, was obtained from a shell fish—the *murex*—sold at the time when Augustus reigned in Rome for a sum equivalent to £30 of our money. As I have mentioned this, it is, perhaps, but fair to say, that the purple of Tyre had an advantage which, in some degrees, compensated for its enormous price. We read that, when the Greeks sacked the treasury of Darius, they found a quantity of cloth dyed with this murex purple, which had retained all its brilliancy of colour after the lapse of 100 years. It was, therefore, essentially what ladies call a "fast" colour. It may not be out of place

* A Lecture delivered before the Royal Dublin Society.

to note, that nearly all the dyes with which we are familiar are of comparatively recent introduction. We never hear of woad now, but this favourite dye of our barbaric ancestors was only replaced by indigo in the reign of Elizabeth. And now, in our own day, indigo is being slowly but surely supplanted by the dyes which form a part of the wonderful series of "Colours from Coal-Tar."

And now we will endeavour, if you please, to follow the progress of this industry. All who hear me know, that in the manufacture of gas, coal is distilled in large retorts, made either of fire-clay or iron, from each of which a vertical tube rises. A number of these retorts are arranged together in a furnace; the retorts are made red-hot, and distillation at once commences.

Both the gas and the oily products of the coal pass up a vertical pipe, and (as this bends on itself) down again into what is called the "hydraulic main." Here all which is not gas condenses, and as the condensed liquid accumulates, it flows into a tank prepared for it. Coke alone remains in the retort. The condensed liquid is *coal-tar*—the body which interests us to-day. Now, this coal tar is, by distillation at a lower temperature, itself separable into two bodies—*pitch* and *tar oil*. The pitch is, as we know, used for the formation of the artificial asphalt, employed for footways, and in the manufacture of coarse black paints or varnishes. In this and other ways all the pitch which it was worth while to make found an outlet; but, because there was almost no other use for the tar oil than "creosoting" timber, it was almost without value. A glance at the diagram which we have here will show us that coal-tar oil is by no means a simple body. Hofmann, indeed, very properly speaks of it as "one of the most wonderful productions in the whole range of modern chemistry." We must not forget that not one of all these substances tabulated here exists *as such* in the coal itself. Indeed, if we were not aware what remarkable changes the simple application of heat is capable of making in most bodies, we should not be prepared for such a splitting up of what, at first sight, seems a very simple body indeed, into all these compounds. This action of heat sometimes shows itself in a very remarkable way. Here is a body: it is a compound of cyanogen and sulphur; and you see, that, as we have it here, it consists of small white lumps of a loosely-aggregated powder. Now, if I apply heat to this body, it changes its form in a very remarkable manner; and, having seen this change of form, you will readily understand that its chemical properties and chemical composition have also undergone complete change. So it is with coal: the mere application of heat, to a certain degree, not only changes its form, but resolves it into all these bodies, each of which has some important chemical difference from its neighbour.

Perhaps, if we only knew how to go to work, we should discover that there are very few things in nature from which we could not obtain colour. But the tendency of these component parts of coal-tar to form coloured compounds is very remarkable. I might show you this by more or less elaborate methods, with almost any one of them; but here is one of the simplest examples. I mix a few drops of this body, which, as we shall have more to say to it presently, I will not describe now. I mix it with the water in this jar, and then add a solution of a persalt of iron. You see we have a violet colouration at once developed. But there are *five* constituents of tar, in which the tendency to give colour is so very marked that all the interest of coal-tar, as a practicable source of colour, centres in them. These five bodies are benzol, toluol, phenol, napthalin, and anthracen; and as it is from these alone that the coal dyes are obtained, we have arranged them here on a separate diagram, in which each is shown, with the principal colours derived from it. You will see, also, specimens of each of these bodies on the table, and will observe some characteristic points of difference, even in their appearance.

Now, in separating these substances from coal-tar oil, advantage is taken, firstly, of differences of boiling point and, secondly, of the various behaviour of these bodies with acids and alkalies. Glancing at the diagram, we see, for instance, that *benzol* boils at 84°; *toluol* at 114°; and *phenol* at 188°; so that, if we subject a mixture of these three bodies to distillation, we shall obtain—first, the benzol; then, as the temperature increases, the toluol; and, finally, when the thermometer reaches 188°, the phenol.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Annual Meeting, April 18th, 1871.

E. W. Binney, F.R.S., F.G.S., President, in the Chair.

Dr. Joule, F.R.S., drew attention to the remarkable atmospheric phenomenon which had been seen by several persons in Derbyshire and elsewhere, on the evening of Good Friday, April 7th, and stated that he had witnessed a similar appearance near Glasgow, on the day before it was observed in this neighbourhood. The perpendicular ray extended upwards from the sun to an altitude of 30°, and was very clearly defined. It was observed from half an hour before until after the sun had set. The phenomenon was also witnessed, at the same time, by Professor J. Thomson, who was sailing on the Firth of Clyde.

The following Report of the Council was read by one of the secretaries:—

The Council have the satisfaction to report that the past year has been one of steady progress for the Society. On the 31st of March, 1870, the general balance of the Treasurer's account was £268 1s. 2d., and on the 31st of March last it had increased to £287 19s. 1½d.

The number of ordinary members on the roll of the Society on the 1st of April, 1870, was 161, and 14 new members have been since elected. The losses during the year have been—Deaths, 1; resignations, 3; and defaulters 2. The number of the roll on the 1st of April instant was therefore 169.

In the last annual Report it was stated that in consequence of the rapid increase of the library of the Society it would be necessary to provide additional accommodation. This has since been done, a new bookcase having been fitted up in the Council room in place of a smaller one which has been removed into the tea room.

The Council refer with pleasure to the fact that the principal result of the recent solar eclipse expedition is due to the energy, intelligence, and skill of a member of the Society, Mr. Alfred Brothers, F.R.A.S., whose beautiful photograph of a solar corona is now generally regarded as having settled the long disputed question as to the real nature of this remarkable phenomenon.

The printing of the fourth volume of the Society's third series of Memoirs has been completed, and a new volume has been commenced.

During the session now ending an important alteration has been made in the terms of admission of Sectional Associates, the annual subscription having been reduced from £1 to 10s., except for those Associates who wish to make use of the Society's library, who will still continue to pay a subscription of £1 per annum.

The librarian reports that he has not been able to send any books to be bound in the course of the past year. The Society continues to receive the publications of those societies to whom our own "Memoirs" and "Proceedings" are sent, but the recent war between France and Germany has to some extent interrupted the transmission of the works of many continental societies.

The following gentlemen were elected officers of the Society and members of the Council for the ensuing year:—

President—Edward William Binney, F.R.S., F.G.S.

Vice-Presidents—James Prescott Joule, D.C.L., LL.D., F.R.S., F.C.S., &c.; Edward Schunck, Ph.D., F.R.S., F.C.S.; Robert Angus Smith, Ph.D., F.R.S., F.C.S.; Rev. William Gaskell, M.A.

Secretaries—Henry Enfield Roscoe, B.A., Ph.D., F.R.S., F.C.S.; Joseph Baxendell, F.R.A.S.

Treasurer—Thomas Carrick.

Librarian—Charles Bailey.

Other Members of the Council—Peter Spence, F.C.S., M.S.A.; William Leeson Dickinson; Henry Wilde; Robert Dukinfield Darbishire, B.A., F.G.S.; Osborne Reynolds, M.A.; William Boyd Dawkins, M.A., F.R.S.

CORRESPONDENCE.

THE PHOSPHATE SEWAGE PROCESS.

To the Editor of the Chemical News.

SIR,—Some time since you were good enough to insert in the CHEMICAL NEWS a letter from myself, asking Dr. Voelcker a question regarding the analysis of the "dried sewage deposit" (prepared according to Dr. Forbes's "patent phosphate process for the utilisation of sewage,") which appeared in No. 589.

The deposit was found by Dr. Voelcker to contain 28·52 per cent of phosphoric acid; 29·95 per cent of alumina and oxide of iron, sufficient to combine with all the phosphoric acid present; also a quantity of lime, insufficient to combine with more than about half the phosphoric acid.

Being considerably interested in phosphatic manures, I was anxious to know how much of the phosphoric acid Dr. Voelcker would consider as being in combination with the alumina, and how much with the lime, for upon this agriculturalists and many manufacturers at present believe the value of the deposit as a manure to entirely depend, the more so because Dr. Voelcker, in his analysis, stated the phosphoric acid to be equal to a certain quantity of phosphate of lime, which, on first reading, may be taken to mean that he considers it to be really in combination with the lime, and not with the alumina and iron as one would suppose from the well known chemical affinity of the acid for these bases.

I looked forward to Dr. Voelcker's reply, in the hope of having my scruples set at rest; but not receiving one, I procured some native phosphate of alumina and made the following experiment. I dissolved the mineral in sulphuric acid, and to the clear saturated solution added milk of lime in slight excess. The precipitate was collected on a filter, well washed, and analysed. I found that the whole of the phosphoric acid which it contained was combined with alumina and a little oxide of iron, mere traces only being soluble in acetic acid, showing the almost complete absence of phosphate of lime.

Now, assuming that all the phosphoric acid present existed as the soluble phosphate of lime, the value of the deposit as a manure would not greatly exceed the value which Dr. Voelcker assigns to it, viz., £7 7s. per ton; but if (as I must infer from my experiment), nearly the whole of the phosphoric acid is combined with alumina and iron, of what value will such a manure be as a fertilising agent? If, indeed, phosphate of alumina be the excellent manure which Dr. Voelcker appears to consider it, from the value he attaches to this "sewage deposit," how is it that Messrs. Lawson and Son do not convert the native mineral phosphate directly into a manure by the ordinary method of treatment with acid, instead of doing so by the very roundabout plan known as Forbes's patent process?—I am, &c.,

SUPERPHOSPHATE.

Royal College of Chemistry, London,
June 20, 1871.

MISCELLANEOUS.

The Abbé Moigno.—As will be seen from our Chemical Notices from Foreign Sources, the Abbé Moigno has again resumed the publication of *Les Mondes*. Subscribers' names and subscriptions will be received at our office. The learned editor was unable to continue his duties during the disasters which attended and followed the late war. He has now, however, resumed them with renewed energy and with the determination to make the journal even more useful than before.

A New Brass.—The difficulty of uniting iron to brass is created by the unequal rate of expansion in the two metals, which destroys the unity when the temperature is changed. A new alloy of copper is announced, and the inventor claims that its expansion by heat is so similar to that of iron and steel, that the surfaces may be regarded, when joined, as permanently united, for all practical purposes. The formula (recently published in the *Journal of Applied Chemistry*) is as follows:—Tin, 3 parts; copper, 39½ parts; zinc, 7½ parts. Any of our readers who have occasion to join iron and brass, can easily try this new "metal," and we shall be glad to hear of the practical value of an idea of such high technical importance.—*Scientific American.*

London Institution.—The managers of the London Institution, in accordance with the recommendation of the annual meeting of proprietors, have resolved to afford opportunities during the ensuing season for the reading and discussion of communications on subjects of special interest in science, literature, commerce, and the arts, provided they receive such offers as will ensure an adequate succession of suitable papers. It is believed that this proposed extension of the use of the Lecture Theatre in Finsbury Circus will produce a series of attractive meetings similar in character to those of the Society of Arts, but representing more directly the business and thought of the city. The managers do not intend to restrict the reading and discussion of papers to the proprietors of the institution, or to limit the range of subjects otherwise than by the provisions of the charter, which preclude politics and theology.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, No. 1, January 2, 1871.

The only paper relating to chemistry and collateral sciences is on—

A Process for Purifying Fatty Substances.—A. Boillot.—The process alluded to is the treatment of the fat—be it suet or any other—with lime-water (*aqua calcis*), heat being applied at the same time. For 1 kilo. of the fatty substance, 2 litres of lime-water are taken. After cooling, the fatty substance is placed in a linen or flannel bag, and submitted to a gentle, but gradually-increased pressure. The fat left in the bag is next melted in hot water to which some sulphuric acid has been added, and after being cooled and well washed with cold water is ready for domestic use,—since it appears from the context of the paper rather that this process is intended to be applied to render fatty substances, otherwise used for soap and candle making, fit for culinary use, the reader being reminded of the condition Paris was in when this paper was published.

No. 2, January 9, 1871.

Historical Account of the Scientific Researches on Gelatine.—E. Chevreul.—The third instalment of this very exhaustive and valuable monograph; not suited, however, for any useful abstraction.

Colza Oil.—A. Wurtz and E. Willm.—The authors state, that when into this oil a current of steam is passed having a temperature of about 120°, there is removed from the oil, which is not thereby to any extent saponified, an acrid principle; and after a washing with a hot solution of carbonate of soda, the oil so purified, after washing, of course, with cold water, may be used for culinary purposes.

The other papers relating to the matters above named bear upon the same or similar subjects, and are rather to be considered as tentative suggestions brought out under peculiar circumstances, and therefore not of general value.

No. 3, January 16, 1871.

This number opens with a valuable essay on—

Dwelling-House Chimneys.—General Morin.

Composition of Milk, and on the Preparation of an Obsidional Milk.—Dr. Dubrunfaut.—The contents of this paper bear only upon the late exceptional condition of Paris, and the scarcity of milk there experienced.

Plan for Utilising the Sewage of Paris.—M. Durand-Claye.—Illustrated by a woodcut.

Nos. 4 and 5, January 23 and 30, 1871.

Do not contain any papers relating to chemistry and collateral sciences.

No. 6, February 6, 1871.

Discovery of Avic Acid in an Albatross.—E. Chevreul.—The eminent author relates at length how, on the 19th of January last, he accidentally made the discovery that the feathers of the well-known large bird called the albatross contain a volatile fatty acid, identical with that which the author has found in the suint of sheep's wool. No further particulars, nor any analysis, of the acid alluded to is here quoted, the author having simply relied on his sense of smell, thereby recognising the well-known odour of the fatty acid alluded to.

Preservation of Potatoes by the Aid of Sulphurous Acid Gas.—V. Labarre.—The author proposes to cause a current of sulphurous acid gas to be passed among the tubers alluded to, either while packed in casks or placed in cellars, since by the use of this gas the fermentation and decay of the potatoes is checked.

Nos. 7, 8, and 9, February 13, 20, and 27; and No. 10, March 6, 1871.

These numbers do not contain papers relating to chemistry and collateral sciences.

No. 11, March 13, 1871.

This number contains the following original paper relating to chemistry:—

Researches on Propylic Bromide and on Butylic Bromide.—I. Pierre and E. Puchot.—The authors describe, at length, the mode of preparation of propylic bromide, C_3H_7Br, by pouring into a long-necked flask 100 parts of pure propylic alcohol, and next, alternately, and by small quantities at the time, 15 parts of phosphorus and from 140 to 145 of bromine, care being taken to keep the phosphorus constantly in excess. After purification of the crude product, a clear, colourless, ethereal liquid is obtained, which boils at 72°, and has at 0° a sp. gr. of 1·349. By contact with moist air, this liquid gradually becomes somewhat coloured. Butylic bromide, C_4H_9Br, is prepared by a similar process to that just alluded to, the only difference being that 120 parts of pure butylic alcohol are taken. The rectified butylic bromide boils at 90·5°, and has at 0° a sp. gr. of 1·249; when freshly prepared, this liquid is colourless, but it soon becomes coloured by a partial decomposition.

No. 12, March 20, 1871.

Preparation of Two Organic Acids obtained by the Reaction of Alkalies upon Silk and Wool.—P. Champion.—*Sericic Acid.*—Raw silk, having been first purified by boiling alcohol, ether, and acetic acid, is treated with boiling baryta-water, whereby a portion of the substance is dissolved; the excess of baryta is removed by carbonic acid from the liquid kept at 80°. After filtration, the filtrate is treated with nitrate of lead, whereby an abundant precipitate is obtained, which, having been collected on a filter and thoroughly washed, is suspended in water and decomposed with sulphuretted hydrogen, the liquid yielding, after filtration and evaporation on a water-bath, an amorphous, slightly yellow-coloured, translucent, deliquescent mass, soluble in alcohol and acetic acid. The baryta salt of this substance, having the same physical properties, was, on analysis, found to yield results leading to the formula $C_{20}H_{28}N_4O_{15}Ba$. *Lanugic acid*, obtained from previously well purified wool by the same process, and yielding a body of similar physical properties, was, on analysis of the baryta salt, found to lead to the formula $C_{20}H_{28}N_2O_{20}Ba$.

No. 13, March 27, and Nos. 14, 15, and 16, April 3, 10, and 17, 1871.

Do not contain any papers relating to chemistry.

No. 17, April 24, 1871.

The only paper relating to chemistry in this number treats on the—

Saccharate of Chloride of Sodium.—Dr. E. J. Maumené.—The author describes, at great length, a series of experiments made with the view to ascertain the precise constitution of the sugar contained in some well-defined large colourless prismatic ortho-rhombic crystals, consisting of 13·295 per cent of chloride of sodium, the rest being sugar, which latter the author's experiments prove to be pure cane sugar; so that thus the compound just alluded to is really a saccharate of chloride of sodium.

No. 18, May 1, 1871.

This number does not contain any papers relating to chemistry.

No. 19, May 8, 1871.

Contains only the following paper bearing on chemistry:—

New Blue Colouring Matter Derived from Eserine.—A. Petit.—Eserine (a very strong base) is carefully saturated with sulphuric acid, and next ammonia in excess is added; the liquid is then evaporated to dryness upon a water-bath, leaving a solid magnificently blue-coloured substance, soluble in alcohol and water, crystallising, and colouring silk blue without the aid of a mordant. The action of acids renders the colour beautifully violet. When eserine is directly treated with ammonia, without having been first saturated with sulphuric acid, there is obtained, on evaporation, a greenish coloured mass, less soluble than that alluded to, and turning wine-red when acted upon by acids. The composition, properties, and mode of formation of the blue pigment alluded to have not been ascertained as yet by the author, who is engaged in further experiments on this subject.

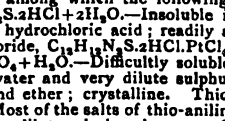
Nos. 20 and 21, May 15 and 29.

The Academy did not meet on May 22. These numbers do not contain any papers relating to chemistry.

Zeitschrift für Chemie von Beilstein, No. 6, 1871.

The only original memoir contained in this number is—

Thio-Aniline and Thio-Toluidine.—V. Merz and W. Weith.—The authors describe, at length, a series of experiments made by them on the action of sulphur upon aniline and toluidine, aided by heat, and best, also, assisted by the simultaneous action of litharge, which greatly accelerates the sulphurisation of the aniline and toluidine, and to some extent prevents the formation of resinous by-products. The result is the formation of thio-aniline, $C_{12}H_{12}N_2S$, a body difficultly soluble in both cold and hot water; but readily so in alcohol, ether, and best in hot benzol, from which it is deposited, on cooling, in crystalline state. Thio-aniline is devoid of smell, has a burning taste, exhibits a neutral reaction to test-paper, and fuses at 105° (when heated under water, it fuses even below 100°); by dry distillation, it at first gives off a very irritating vapour, next chiefly aniline and sulphuretted hydrogen, leaving a large quantity of carbonaceous residue. Thio-aniline behaves as a diamine, fixing 2 equivalents of acid without neutralising it; the salts are generally crystalline. The authors describe a series of these salts, among which the following:—Thio-aniline-chlorhydrate, $C_{12}H_{12}N_2S.2HCl+2H_2O$.—Insoluble in ether, alcohol, and cold concentrated hydrochloric acid; readily soluble in water. Thio-aniline-platin-chloride, $C_{12}H_{12}N_2S.2HCl.PtCl_4$. Thio-aniline-sulphate, $C_{12}H_{12}N_2S.SO_4+H_2O$.—Difficultly soluble in cold water; more readily so in hot water and very dilute sulphuric acid; almost insoluble in alcohol and ether; crystalline. Thio-aniline-oxalate, $C_{12}H_{12}N_2S.H_2C_2O_4$.—Most of the salts of thio-aniline exhibit an acid reaction; even their very dilute solutions impart to fir-wood a beautiful orange colour; with chloride of iron, an intensely blue violet colouration is produced. Thio-aniline is, like the baloid aniline compounds, a very stable body; treated with chloracetyl, the benzol solution of thio-aniline yields thio-acetanilide—



This substance is readily soluble in boiling alcohol, but difficultly so in ether and water; it is a crystalline body which, instead of being prepared as just stated, is more readily obtained by boiling the thio base for several hours with concentrated glacial acetic acid, the only difference between these two preparations being the point of fusion, which, for the chloracetyl preparation, is 213·5°, for the other 215°. Thio-sulpho-carbanilide is obtained by the action of alcoholic solutions of sulphide of carbon and of thio-aniline upon each other. The authors next treat on the resinous products of the sulphurisation of aniline; the purified resinous matter, dried at 120°, yielded 20·87 per cent of sulphur. Thio-toluidine, $C_{14}H_{16}N_2S$, a crystalline substance, almost insoluble in water, very readily so in ether, and tolerably so in alcohol; devoid of taste and smell; reaction neutral; fuses at 103°. This base forms salts with acids, but they are decomposed by a large quantity of water; the salts exhibit a strongly acid reaction. Toluidine-chlorhydrate, $C_{14}H_{16}N_2S.2HCl$, a crystalline salt, yielding, with platinum-chloride, a double salt, $C_{14}H_{16}N_2S.2HCl+PtCl_4$. Thio-toluidine-sulphate, $C_{14}H_{16}N_2S.H_2SO_4$, contains 28·66 per cent of sulphuric acid, is decomposed by boiling water, insoluble in alcohol, and soluble in very dilute sulphuric acid. The authors briefly mention a series of experiments made with the view of the sulphurisation of benzol, but none of these experiments led to the desired result. The passing of vapours of benzol over black sulphuret of antimony heated to redness caused the benzol to be converted into diphenyl.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 4, 1871.

This number contains the following original memoirs and papers relating to chemical and collateral sciences:—

Steam-Boiler Explosions.—Prof. Melsens.—The first instalment of a very important memoir on this highly interesting subject.

Second Paper on the Action of Iodate of Potassium upon the Animal System.—Prof. Melsens.—The contents of this paper belong rather to the domain of experimental physiology than to that of chemistry. The poisonous action of even comparatively small doses of iodate of potassium cannot, as is well observed by the author, be simply due to chemical action, that is to say, to a kind of combustion, whereby organic matter present in the body of animals is destroyed. It appears that the centres of the nervous system are acted upon in a peculiar manner, and that the organised structure of the blood is destroyed, that liquid itself becoming chemically altered at the same time. The author continues his researches on this subject.

Observations on the Constitution of the Carboniferous Limestone of Belgium.—E. Dupont.—An important geological essay illustrated by woodcuts.

Spots on the Sun, as seen and observed at the Astronomical Observatory at Leuven (Louvain) during the years 1864 to 1867 inclusive.—Dr. F. Terby.—Illustrated by a series of engravings.

Annales de Chimie et de Physique, October, 1870.

This number contains the following original papers and essays:—

Experimental Researches on the Sound Produced by Conically-Shaped Organ Pipes.—Dr. J. F. Boutet.—This lengthy essay, illustrated by a series of woodcuts, is divided into the following sections:—General description of the method of executing the experiments; exposition of the calculation of M. Duhamel; experimental verification of the laws set forth by mathematical analysis and applied to conical pipes; comparative and completing observations on cylindrically-shaped organ pipes.

Memoir on the Acetic Derivatives of the Carbo-Hydrates of Mannite and Substances Isomeric therewith, and of some other Vegetable Substances.—Dr. P. Schützenberger.—This is the first portion of a lengthy monograph on this subject. However valuable and interesting in a scientific point of view, it is not possible to quote here more than the headings of the various chapters of this essay—Cellulose and acetic anhydride; amylaceous matter and acetic anhydride; glycogene and acetic anhydride; gum arabic, inuline, glucose, cane sugar, and lactic anhydride with acetic anhydride.

Journal für Praktische Chemie, No. 7, 1871.

This number opens with the continuation of the very lengthy and exhaustive monograph on the—

Dissociation Phenomena Exhibited by Aqueous Solutions of Chloride of Iron.—Dr. F. W. Krecke.—However valuable this work may be, it is not suited for useful abstraction, since the value of the essay is in a great measure owing to the exhaustive tabulated results of a large number of experiments.

Leucine from the Proteine Compounds of Plants.—Drs. H. Ritthausen and U. Kreussler.—This essay contains the following sections:—Preparation and composition of leucine; combustion of leucine with soda-lime; behaviour of the leucine towards the nitrates of mercury; leucin-cupric oxide.

Dispersion of Asparaginic and Glutaminic Acid met with among the Products of the Decomposition of Proteine Compounds.—Drs. H. Ritthausen and U. Kreussler.—100 parts of the following proteine compounds of vegetable origin were found to yield, of asparaginic acid, the following quantities per cent:—Fibrine from Indian corn, 1·4; a mixture of vegetable glue, mucedine, and fibrine, 1·1; gluten-caseine, 0·33; conglutine, 2·0; legumine, 3·5. And of glutaminic acid, per cent—Mucedine, 25; fibrine from Indian corn, 10; mixture of vegetable glue, mucedine, and fibrine, 8·8; gluten-caseine, 5·3; conglutine, 3·5; legumine, 1·5. Proteine compounds of animal origin do not yield any glutaminic acid among the products of their decomposition, but, as the same compounds of vegetable origin, yield asparaginic acid.

Chemical Change Undergone by Silver which had been Buried for a considerable length of time.—Dr. A. Schertel.—The contents of this paper are, inclusive even of the results of analysis, strikingly in accordance with Professor Church's paper on brittle silver (see Chemical News, vol. xxiii., p. 243). The paper of the author named above relates to some treasure trove near Hildesheim.

Bayerisches Industrie und Gewerbe Blatt, April, 1871.

This number contains the following original matter relating to chemistry and allied sciences:—

Prussian Association for the Promotion of Industry at Berlin.—From the programme containing the questions to which the Council of this Society desires to receive answers, the following relate to chemistry:—The gold medal of the Association, or the value thereof in money, and in addition thereto a sum of £150, will be given to the author who gives a thoroughly reliable and satisfactory method, readily executable, of determining the quantity as well as the various compounds met with in the commercial aniline (aniline oil, as it is also termed), and also determines the influence which the diversity of these compounds exercises upon the manufacture, as well as upon the yield of fuchsine; it being also desired that the author should examine and plainly explain under what conditions aniline yields the largest quantity of colouring matter. The silver medal, or money-value thereof, and a sum of £45, will be given for the preparation of an opaque red enamel on gold, silver, copper, or bronze. A donation of £37 10s. will be given to the author of a concise and critical work especially bearing upon the wants of industry in relation to the composition of cements. The silver medal, or the money-value thereof, and, in addition thereto, a sum of £22 10s. will be given to the author of an exhaustive essay on the industrial manufacture, mode of formation, and chemical constitution of corallin (also known as aurin, rosolic acid, and peonin), and on the blue pigment, azuline, derived from it. The silver medal, or its value in money, and, moreover, £75, will be given to the inventor of a yellow-coloured solder which possesses the qualities and properties of the ordinary tinman's solder. The aim of this solder should be to join therewith brass, or similar alloys, in such a manner as to hide the joints from being visible by the different colour exhibited by the solder.

Contribution to the Industrial Statistics of Bavaria.—Dr. M. Haushofer.—A very valuable and exhaustive essay bearing upon the science of political economy in general, and especially exhibiting the high industrial standing of Bavaria.

Analysis of the Water of an Artesian Well Recently Bored at the Brewery of G. Sedlmayr, at Münich.—Dr. H. Schilling.—The well has a depth of 56 metres, and yields, without interruption, 10,000 litres of water per hour, the temperature of which is +9·2° R. (= about 12° C.). 1 litre of this water contains 0·3264 grms. of solid constituents, the salts being calculated as bicarbonates. The percentage composition of this water (it should be borne in mind that the city of Münich is situated at an elevation of 538 metres above sea level) is as follows:—Silica, 4·47; sulphate of potassa, 2·94; sulphate of soda, 0·95; chloride of sodium, 0·15; nitrate of soda, 6·04; bicarbonate of soda, 17·65; bicarbonate of lime, 36·79; bicarbonate of magnesia, 23·80; oxide of iron and trace of alumina, 0·31; organic matter, 6·90. As compared with the ordinary pump-water at Münich, the latter contains 0·848 grms. of solid matter to the litre, including 15·55 per cent of nitrate of lime and 8·85 per cent of organic matter.

NOTES AND QUERIES.

Cheap Electricity.—Mr. Highton informs us that he has discovered the way to consume carbon as the positive in the battery. Further details will shortly be given.

Hydrate of Chloral.—(Reply to "W. E.")—You will find all the particulars you require in vol. xxi., of the Chemical News, pp. 22, 167, 179, and 227; also vol. xxii., pp. 23 and 46.

Disulphide of Carbon.—(Reply to "Sulphur.")—This fluid is largely made in this country and on the continent; it is chiefly used in the caoutchouc and gutta-percha works, and very extensively, also, in the extraction of oils and fats. The price per pound, wholesale, will depend very much upon the quantity to be delivered at once, and also upon the purity.

Disulphide of Carbon.—(Reply to "Sulphur.")—I believe the demand for this in England to be good. It is largely used by varnish-makers, manufacturers of vulcanised india rubber, and for the extraction of fatty matters from shoddy and from greasy refuse of various kinds. The price paid by the writer is about £28 per ton; as far as his knowledge extends, there are only three or four makers in England. —Shoddy.

Estimation of Sulphur in Dense Coke.—(Reply to S. Reddrop.)—Take care to reduce the coke to an impalpable powder, by grinding it in an agate mortar to begin with; next, procure perfectly pure nitrate, or chlorate of potassa free from sulphuric acid. Fuse an excess of either of these salts in a capacious platinum crucible, and, while in fusion, add, with a clean platinum spatula, gradually, your weighed quantity of coke to the fused mass, taking care to cover the crucible with the lid immediately after every addition of a small quantity of the coke-powder at the time; you will, in this way, and with a good strong heat of the crucible—to be distinctly visibly red in daylight—burn off carbon and sulphur, the latter forming sulphate of potassa. After having quite cooled the crucible, treat first with hot water, so as to dissolve the contents, next add, gradually and carefully, to the liquid an excess of hydrochloric acid, and estimate the sulphuric acid in the well-known way with baryta. From the sulphate obtained, calculate the quantity of sulphur.—Dr. A. A.

TO CORRESPONDENTS.

J. W.—The preparation of nitro-prusside of sodium is given in most manuals of chemistry.

Digamma.—The secretary will give you all the information you require.

M. M. P. M.—We cannot well give the names of makers of chloral; our advertisement columns should give you the information.

J. Charlton.—The process is given in every work treating on water analysis.

W. Russell.—The second edition has not yet appeared.

W. Tate.—The action you refer to has, we should think, been observed by every student of chemistry; hence our reason for not inserting your former note.

C. B. Bidwell (Middletown, Conn.).—Received, with thanks.

Prof. Fittig (Tübingen).—Our publisher will comply with your request as far as he is able.

E. W. Prevost (Heidelberg).—Duplicates of the numbers have been forwarded to you.

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SUGGESTIONS FOR THE IMPROVEMENT OF THE METHODS EMPLOYED IN QUALITATIVE ANALYSIS.

By A. H. ALLEN, F.C.S.

IT is not supposed that the following remarks contain much that is new, or that experienced chemists would have any difficulty in avoiding error, but I am anxious to call the attention of teachers to the existence of the defects, and the means I would suggest for their removal.

When imparting instruction in qualitative analysis, I have frequently found that the pupils have a difficulty in ascertaining that the substance under investigation is a metallic oxide or hydrate. In my opinion, there are few works on qualitative analysis which give anything like sufficient prominence to these important classes of compounds. Ordinarily, the student is directed to search first for the metal and then for the "acid," and there is generally some short note or observation to the effect that "if no acid can be detected, the substance is probably an oxide or hydrate." I have always found it preferable to test for these classes of compounds before proceeding to the method for the detection of other salt radicles. It is a curious fact that in two recent works on qualitative analysis little or no notice is taken of the solubility of various compounds. In my opinion, the solubility is a most important aid in the analysis of both simple and complex substances, and the manuscript "tables of solubilities" used by my pupils have the solvents for all the important classes of salts, with the addition of the *colour* when this is peculiar and characteristic, and notes in certain cases.

When the metal is ascertained, and the solvent for the substance known, it is very easy to look at this table and learn from it whether the solubility and colour are in accordance with those of any oxide or hydrate of the metal detected. If not, the ordinary method is in no way lengthened; but should the properties agree it is much better to try a few tests to ascertain if the substance be really an oxide or hydrate, than to wade through a tedious method for the detection of salt radicles, and then get the same result in the end "by difference."

Again, a method for the analysis of simple salts ought to be applicable to any ordinary inorganic solid or liquid likely to occur in a laboratory in a single bottle. Thus, if many analytical systems be followed, potassium chromate can only be analysed by a method for mixtures, though it is essentially a "simple substance containing one base and one acid." Ferro- and ferricyanides are not of more frequent occurrence than the permanganates, yet few text-books give any hint of the properties of the latter salts, or contain any note of the abnormal reactions their presence would occasion. Sodium aluminate is, to all intents and purposes, a simple salt, and it is tolerably frequently met with, but if the student examine it by almost any of the ordinary text-books he will fail to ascertain its composition, and trying in vain for an "acid" will begin to think he has met with a soluble oxide or hydrate of aluminium. Sodium stannate, arsenite, and arseniate, are other instances of the same difficulty. Of course it may be said that the student is not supposed to work alone, and that these difficulties will be explained away as they arise; but why should the majority of text-books take no notice of them, or only refer to them in another part of the book instead of calling attention to a possible result in the place where the difficulty would occur.

For these reasons, I direct my pupils to detect the metal first, and then to refer to a table containing descriptions of the chief oxides, hydrates, and anomalous compounds of each metal, while at the same time he is warned that every mentioned property and reaction of the oxide, &c., must be realised before deciding that it is really that compound of the metal. The classes of salts most liable to be mistaken for oxides or hydrates are the sulphides and carbonates, and in some cases the phosphates, arseniates, and oxychlorides. Possibly, a few examples may make my meaning clearer.

(1.) The substance under examination is supposed to be simple, and the metal has been proved to be magnesium. The substance is white, and insoluble in water, but readily soluble in HCl. Instead of going through the whole method for the detection of salt radicles, and coming at last to the conclusion that the substance is MgO, the analyst looks at the table of oxides, &c., and finds the following particulars under the head "Magnesium."

"*Magnesium.*	Oxide, Mg"O.	White, insoluble in water, soluble in HCl without sensible effervescence. Turns yellow when boiled with $HgCl_2$. Turns wet red litmus-paper blue. The hydrate gives off water at a red heat."
	Hydrate, Mg"Ho_2.	

These few reactions are sufficient to distinguish the oxide or hydrate from any other compound of magnesium.

(2.) The substance is black, insoluble in water, soluble in HCl, and has been found to contain copper. Of course, an advanced student would immediately suspect that it was CuO, especially as Cu_2S and CuS are only dissolved by HCl with great difficulty. But the student with a limited knowledge and a short memory would probably wander through the whole acid method, while he might at once detect the nature of the substance by looking at such a table as I describe, where he would read—

"*Copper.*	Cuprous oxide, Cu_2'O. Red. Cuprous hydrate. Yellow.	Soluble in HCl, without effervescence or smell of H_2S.
	Cupric oxide, Cu"O.	Black. Soluble in HCl, without effervescence or smell of H_2S.
	Cupric hydrate, Cu"Ho_2.	Bluish. Turns to black CuO when boiled in water. Soluble in HCl, without effervescence or smell of H_2S."

One more instance will suffice. (3.) The substance is white, soluble in water, and has been found to contain barium. The Table says—

"*Barium.*	Barium oxide, Ba"O. Barium hydrate, Ba"Ho_2.	White or grey. Soluble in water; solution alkaline to litmus, and gives brown Ag_2O with $AgNO_3$. Aqueous solution does not effervesce, or evolve H_2S with HCl. The hydrate gives off water when heated to redness with dry SiO_2.
	Barium dioxide, BaO_2.	White. Insoluble in water; soluble in HCl. The solution bleaches and liberates I from KI."

This plan is not merely more speedy and accurate than that usually followed, but it familiarises the student with the properties of the various oxides, and gives them their

proper position of precedence. The method for detecting sulphides is not always clearly laid down, and I think might be improved.

Another fault that is common in works on qualitative analysis is the omission of any systematic means of detecting the salts of hydrogen. Considering how important and common are many of the compounds of this "metal," it should have a definite place in the analytical method. Sourness, and the property of reddening litmus-paper, are general properties of the salts of hydrogen, which should no more cause it to be slurred over than the sweet taste of lead compounds, the blue or green colour of salts of copper, or the tendency of silver compounds to blacken in the light, are reasons for the exclusion of these metals from the general method. Of course, hydrogen will be grouped with potassium, sodium, and ammonium, and the students must be taught to ascertain whether the *original* substance is an acid or anhydride. A few simple tests will generally decide this question, a table of the properties of the principal acids, anhydrides, and salt radicles being employed for the purpose.

In many handbooks there is to be found a direction somewhat to the following effect. "Before passing H_2S, if arsenic has been found in the preliminary examination, the solution must be boiled with sulphurous acid."

Now, this renders it *necessary* to make a "preliminary examination," which is not always convenient, especially with a liquid, and in the hands of beginners the dry test for arsenic is very liable to failure when applied to the sulphides of arsenic and the arseniates. Suppose sodium arseniate is under examination, this direction would make it necessary to examine the substance as a "mixture," while no difficulty will be met with if the following plan be employed. Omit the reduction with sulphurous acid, and, in all probability, the arsenic will not be thrown down by H_2S, and the analyst will find the metal to be sodium. The method for the detection of salt radicles will then readily reduce the question to the phosphate or arseniate, which, of course, are distinguished by silver nitrate. If H_2S does produce a precipitate, arsenic will be detected, and, on reference to the above-mentioned table of oxides and anomalous substances the analyst will learn that the brown Ag_3AsO_4 produced with silver nitrate indicates an arseniate, its incomplete volatility shows that it is not the hydrogen or ammonium salt (or arsenic pentoxide), and a reference to the table of solubilities will tell him that the only other arseniates soluble in water are those of potassium and sodium. The same plan would be preferable if arseniate of calcium or iron were under examination, the arseniate being mistaken for phosphate up to a certain point, and then readily distinguished from the latter.

I am engaged on a work on analysis in which the above suggestions are incorporated, and I shall be obliged to anyone who will assist me in reducing the chances of error for beginners in analysis.

ON THE ACTION OF HYDROBROMIC ACID ON CODEIA AND ITS DERIVATIVES.*

By C. R. A. WRIGHT, D.Sc.,
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IT has been shown in Part I. of this research† that the action of hydrobromic acid on codeia gives rise, without evolution of methyl bromide, first to bromocodide, and secondly to two other new bases termed respectively deoxycodeia and bromotetracodeia, the latter of which, under the influence of hydrochloric acid, exchanges bromine for chlorine, yielding a corresponding chlorinated base, chlorotetracodeia; when, however, the action of hydrobromic acid is prolonged, methyl bromide is evolved in some little quantity. By digesting codeia with three or four times its weight of 48 per cent acid for five or six hours on the water-bath, vapours were evolved which, condensed by the application of a freezing mixture to a colourless mobile liquid, the boiling-point of which was found to be 10·5° to 11·5°, and the vapour of which burnt with a yellow-edged flame, exploded violently with oxygen, forming carbonic and hydrobromic acids; it becomes, therefore, of interest to examine in detail the action of hydrobromic acid on each of the three bodies produced from codeia under its influence.

1. *Action of Hydrobromic Acid on Bromotetracodeia.*

When bromotetracodeia hydrobromate is heated in a sealed tube to 100° with four or five times its weight of 48 per cent hydrobromic acid for from six to ten hours, methyl bromide is found as a thin layer on the top of the tarry contents of the tube after cooling; by dissolving this tarry substance in water and fractionally precipitating the liquid by strong hydrobromic acid several times successively, nearly white amorphous flakes are ultimately obtained, resembling in all their physical and chemical properties the bromotetracodeia hydrobromate originally employed. After desiccation, first over SO_4H_2, and finally at 100°, there were obtained numbers which correspond with those required for a base bearing the same relation to morphia that bromotetracodeia does to codeia; it is, therefore, provisionally named bromotetramorphia.*

Hence the action of hydrobromic acid on bromotetracodeia is

$$\underbrace{C_{22}H_{83}BrN_4O_{12}}_{\text{Bromotetracodeia.}} + 4HBr = 4CH_3Br + \underbrace{C_{68}H_{75}BrN_4O_{12}}_{\text{Bromotetramorphia.}}.$$

Carbonate of soda throws down from the solution of the hydrobromate a nearly white precipitate which rapidly oxidises, and appears identical in all its physical properties and chemical reactions with bromotetracodeia.

When crude bromotetramorphia hydrobromate is precipitated by carbonate of soda, and the precipitate (after filtration and washing) re-dissolved in hydrochloric acid and fractionally precipitated twice or thrice by strong hydrochloric acid, white flakes free from bromine are ultimately obtained; these are the hydrochlorate of the corresponding chlorinated base, which is therefore termed chlorotetramorphia. After drying at 100°, numbers were obtained which led to the formula $C_{60}H_{75}ClN_4O_{12},4HCl$.

Converted into platinum-salt and dried at 100°:—

0·4235 grm. gave 0·0840 Pt = 19·83 per cent.

The formula $C_{68}H_{75}ClN_4O_{12},4HCl,2PtCl_4$ requires 19·72 per cent.

When codeia is heated on the water-bath with three parts of 48 per cent hydrobromic acid for five hours, and the portion of the precipitate thrown down by carbonate of soda and insoluble in ether is dissolved in hydrochloric acid, and fractionally precipitated several times by excess of stronger acid, flakes are obtained which, on drying at 100°, yield numbers intermediate between those required for chlorotetracodeia and chlorotetramorphia, leading to the formula $C_{70}H_{79}ClN_4O_{12},4HCl$.

Converted into platinum-salt, and dried at 100°:—

0·4830 grm. gave 0·0935 Pt = 19·36 per cent.

The formula $C_{70}H_{79}ClN_4O_{12},4HCl,2PtCl_4$ requires 19·40 per cent.

Whether this is only a mixture of chlorotetracodeia and chlorotetramorphia hydrochlorates, or is one compound, is open to doubt; assuming that it is not a mixture, the name chloro-dicodeia-dimorphia might be applied to the base. It appears *à priori* probable that the following double series of bases should be obtainable by successive methyl eliminations:—

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* Read before the Royal Society, June 15, 1871.

† *Proc. Roy. Soc.*, vol. xxi., p. 317.

* All combustions given in this paper were made by lead chromate and oxygen; except where otherwise stated, chlorine and bromine were determined by boiling with silver nitrate and nitric acid.

Bromotetracodeia	$C_{72}H_{83}BrN_4O_{12}$
	$C_{71}H_{81}BrN_4O_{12}$
	$C_{70}H_{79}BrN_4O_{12}$
	$C_{69}H_{77}BrN_4O_{12}$
Bromotetramorphia	$C_{68}H_{75}BrN_4O_{12}$
Chlorotetracodeia	$C_{72}H_{83}ClN_4O_{12}$
	$C_{71}H_{81}ClN_4O_{12}$
Chloro-dicodeia-dimorphia	$C_{70}H_{79}ClN_4O_{12}$
	$C_{69}H_{77}ClN_4O_{12}$
Chlorotetramorphia	$C_{68}H_{75}ClN_4O_{12}$

Out of these ten bases four have been prepared, and a substance corresponding in composition with a fifth (chloro-dicodeia-dimorphia) has also been obtained; but from the great similarity in properties between all the five substances and their high formulæ, it is clear that no certainty as to the purity of the missing intermediate bodies could exist, and therefore it was not thought advisable to attempt their formation.

2. *Action of Hydrobromic Acid on Bromocodide.*

When bromocodide hydrobromate (prepared by two hours' digestion of codeia with three times its weight of 48 per cent HBr, precipitation by sodium carbonate, and extraction with ether, &c.) is heated with four to six parts of the same acid to 100° for five or six hours either in a sealed tube or in an open flask, methyl bromide is copiously evolved; the tarry product, dissolved in warm water and precipitated by sodium carbonate, is for the most part insoluble in ether, the insoluble portion having all the properties of bromotetramorphia; the ethereal extract shaken with HCl or HBr yields a viscid liquid, which, on standing, becomes filled with crystals consisting apparently of a mixture of the hydrochlorates, or hydrobromates, of deoxycodeia and a lower homologue, the latter predominating when the digestion is performed in an open flask. Attempts to prevent the formation of the lower homologue by continuing the digestion with HBr for only two or three hours did not succeed, as the large quantity of unaltered bromocodide in the ether extract obtained prevents the separation of the crystalline hydrochlorate or hydrobromate of deoxycodeia, and hitherto no method of separating the deoxycodeia salt from its lower homologue has been arrived at.

The following numbers were obtained by the analysis of these crystals after re-crystallisation from hot water to free them from adhering bromocodide-salt:—

Specimen A, prepared in sealed tubes, digested six hours at 100°:—

0·3185 grm. gave 0·7850 CO_2 and 0·1970 H_2O.

0·2200 grm. gave 0·1025 AgCl.

Specimen B, prepared in an open flask, digested six hours at 100°:—

0·2825 grm. gave 0·6920 CO_2 and 0·1660 H_2O.

0·2260 grm. gave 0·1085 AgCl.

	Calculated.				Found.	
	Deoxycodeia.		Deoxymorphia.			
C	216	67·60	204	66·77	67·22	66·80
H	22	6·89	20	6·55	6·87	6·54
N	14	4·39	14	4·59		
O_2	32	10·01	32	10·47		
Cl	35·5	11·11	35·5	11·62	11·53	11·88
	319·5	100·00	305·5	100·00		
	$C_{18}H_{21}NO_2,HCl$		$C_7H_{19}NO_2,HCl$			

The hydrobromate, prepared from the same batch as specimen B above, gave the following numbers after drying at 100°:—

0·3260 grm. gave 0·7010 CO_2 and 0·1720 H_2O.

0·2730 grm. gave 0·1465 AgBr.

	Calculated.				Found.
	Deoxycodeia.		Deoxymorphia.		
C	216	59·34	204	58·29	58·64
H	22	6·05	20	5·71	5·86
N	14	3·84	14	4·00	
O_2	32	8·79	32	9·14	
Br	80	21·89	80	22·86	22·83
	$C_{18}H_{21}NO_2,HBr$ 364	100·00	$C_{17}H_{19}NO_2,HBr$ 350	100·00	

From the above numbers, and more especially from the percentages of H, Cl, and Br found, it appears that while specimen A may have contained some little quantity of deoxycodeia, specimen B must have consisted almost wholly of the lower homologue; to this body the name deoxymorphia may appropriately be given (provisionally). to indicate that its composition bears the same relation to that of morphia as deoxycodeia to codeia.

The numbers required for apomorphia salts are very close to those actually obtained above, viz., for hydrochlorate C = 67·22, H = 5·93, Cl = 11·70; and for hydrobromate C = 58·62, H = 5·17, Br = 22·99; but the entire absence of emetic properties in all these specimens, as observed by Dr. Michael Foster, conclusively proves that this base could not have been present.

Further research is required before it can be decided with certainty which of the three oxygen atoms in codeia is removed in the formation of deoxycodeia; the production of deoxymorphia with simultaneous evolution of methyl bromide, however, indicates that the oxygen that links the methyl group to the rest of the codeia residue is still present in deoxycodeia and deoxymorphia, while the production of both from bromocodide renders the following formulæ probable:—

Codeia. $C_{17}H_{17}NO\begin{cases}OH\\O.CH_3,\end{cases}$ Bromocodide. $C_{17}H_{17}NO\begin{cases}Br\\O.CH_3,\end{cases}$

Deoxycodeia. $C_{17}H_{17}NO\begin{cases}H\\O.CH_3,\end{cases}$ Deoxymorphia. $C_{17}H_{17}NO\begin{cases}H\\OH;\end{cases}$

so that deoxycodeia probably bears to codeia the same relation as free hydrogen, H_2, to water, H.OH; or as acetic acid, $\begin{matrix}CH_3\\CO.OH\end{matrix}$, to glycollic, $\begin{matrix}CH_2.OH\\CO.OH\end{matrix}$; bromocodide corresponding similarly to hydrobromic acid, HBr, or to bromacetic acid, $\begin{matrix}CH_2Br\\CO.OH.\end{matrix}$

Experiments are in progress to gain further insight into the structure of the group $C_{17}H_{17}NO$. By the action of hydriodic acid on codeia methyl is eliminated as iodide, and the elements of free hydrogen and those of HI are added on to this group; from which, as well as from the easy polymerisation to form tetracodeia bases, it appears probable that some at least of the 17 carbon atoms are connected together somewhat after the fashion of ethylene or acrylic acid, which unite readily with HI, HBr, H_2, &c. Again, the oxidising action of $AgNO_3$ on chlorotetramorphia is accompanied by the production of CO_2, which renders it not improbable that the third oxygen atom exists either as the group [CH(OH)]" or as CO".

On carefully examining, side by side, the qualitative reactions of the hydrochlorate B and those of a specimen of pure deoxycodeia-salt from codeia (without evolution of methyl bromide), not the slightest difference was discernible between the two; in their physiological actions, too, as observed by Dr. Michael Foster, the two bodies seem perfectly alike, both being utterly dissimilar from apomorphia, from which in all other respects (qualitative reactions, percentage composition, &c.) they differ either not at all, or extremely little.

The portion insoluble in ether of the batch from which hydrochlorate B was obtained was treated with HCl and fractionally precipitated by strong acid several times successively; this mode of treatment was adopted rather than that with HBr, as a much larger yield is obtained thus, the hydrochlorates of chlorotetracodeia and chlorotetramorphia being much less soluble in dilute HCl than the corresponding brominated bodies are in dilute HBr. Finally, nearly white flakes were obtained, presenting all the characters of chlorotetramorphia hydrochlorate, and yielding the following numbers after drying at 100°:—

0·2480 grm. gave 0·5610 CO_2 and 0·1410 H_2O

0·1390 grm. gave 0·0755 AgCl.

		Calculated.		Found.	
C_{68}	.. ..	816·0	61·79	61·70	
H_{79}	.. ..	79·0	5·98	6·32	
Cl_5	.. ..	177·5	13·44	..	13·45
N_4	.. ..	56·0	4·24		
O_{12}	.. ..	192·0	14·55		
$C_{68}H_{75}ClN_4O_{12},4HCl$		1320·5	100·00		

Hence the portion insoluble in ether must have been bromotetramorphia.

The simultaneous formation of bromotetramorphia and deoxymorphia from bromocodide is explainable in two ways: either

(I.) $\underbrace{5C_{18}H_{20}BrNO_2}_{\text{Bromocodide.}}+4H_2O=$

$=\underbrace{C_{72}H_{83}BrN_4O_{12}}_{\text{Bromotetracodeia.}}+\underbrace{C_{18}H_{21}NO_2}_{\text{Deoxycodeia.}}+4HBr.$

(II.) $\underbrace{C_{72}H_{83}BrN_4O_{12}}_{\text{Bromotetracodeia.}}+4HBr=$

$=\underbrace{C_{68}H_{75}BrN_4O_{12}}_{\text{Bromotetramorphia.}}+4CH_3Br.$

(III.) $\underbrace{C_{18}H_{21}NO_2}_{\text{Deoxycodeia.}}+HBr=\underbrace{C_{17}H_{19}NO_2}_{\text{Deoxymorphia.}}+CH_3Br$; or

(IV.) $\underbrace{C_{18}H_{20}BrNO_2}_{\text{Bromocodide.}}+HBr=\underbrace{C_{17}H_{18}BrNO_2}_{\text{Bromomorphide.}}+CH_3Br.$

(V.) $\underbrace{5C_{17}H_{18}BrNO_2}_{\text{Bromomorphide.}}+4H_2O=$

$=\underbrace{C_{68}H_{75}BrN_4O_{12}}_{\text{Bromotetramorphia.}}+\underbrace{C_{17}H_{19}NO_2}_{\text{Deoxymorphia.}}+4HBr.$

Of these two views, the first involves only known substances and reactions similar to those already known in the codeia series of derivatives, and is, moreover, probable from the circumstance that the numbers obtained in some instances indicate the presence of deoxycodeia as well as deoxymorphia; whilst the second view involves the not improbable existence of bromomorphide, $C_{17}H_{18}BrNO_2$; on the other hand, it will be shown in the next section that equation (III.) represents a reaction which does not readily take place with deoxycodeia, when not in the nascent condition at any rate.

Whichever view be adopted, the ultimate formation of bromotetramorphia requires the action of water on a brominated body, substituting hydroxyl for bromine by a reaction perfectly parallel to that whereby codeia is regenerated from chlorocodide by the action of water,* viz.:—

$$C_{18}H_{20}ClNO_2+H_2O=HCl+C_{18}H_{21}NO_3.$$

3. *Action of Hydrobromic Acid on Deoxycodeia.*

In the hope that this action would give rise to methyl bromide and deoxymorphia, deoxycodeia hydrobromate was heated to 100° for two hours with about five parts of 48 per cent HBr; no change whatever took place, no methyl bromide being found on opening the tube in which the digestion was carried on after complete cooling. After an hour's additional exposure to a temperature of 120°—130°, the contents of the tube were found to have become black and tarry, while a small quantity of methyl bromide floated on the top. Precipitated by sodium carbonate, a very dirty substance was obtained, which was almost insoluble in ether; the ethereal extract, shaken with HBr, gave a small quantity of a tarry hydrobromate, of which 0·1330 grm. gave 0·0790 AgBr, or Br=25·20 per cent, deoxymorphia hydrobromate requiring only 22·86 per cent.

Nothing fit for analysis could be obtained from the portion insoluble in ether, and the minute yield of pure deoxycodeia from codeia precluded a repetition of the experiment.

4. *On the Physiological Action of the Foregoing Codeia Derivatives.* By Michael Foster, M.A., M.D.

The hydrochlorate of chlorotetracodeia and the hydrobromate of bromotetramorphia, in doses of a decigramme by subcutaneous injection or by the mouth, produced in adult cats in a very few minutes a condition of great excitement, almost amounting to delirium, accompanied by a copious flow of saliva and great dilatation of the pupils. Micturation and defæcation occurred in some instances, and vomiting was observed on two occasions with the morphia-salt, but was very slight. The excitement was very peculiar, being apparently due partly to increased sensitiveness to noises, and partly to an impulse to rush about.

The same doses of the morphia-salt given to a young kitten produced the same flow of saliva, dilatation of pupils, and excitement (without vomiting); but the stage of excitement, which in adult cats passed gradually off in a few hours, was followed by a condition marked by a want of co-ordination of muscular movements, and presenting the most grotesque resemblance to certain stages of alcoholic intoxication. This stage was followed in turn by sleepiness and stupor, in which the kitten was left at night; in the morning it was found dead.

Two observations have shown these salts paralyse (in dogs and cats) the inhibitory fibres of the pneumogastric; they also seem to lower the internal tension, but want of material has prevented from ascertaining how this is brought about.

On *rabbits* neither salt, even in doses of a decigramme, seems to have any effect, except perhaps a slight excitement. There is no dilatation of the pupils, no flow of saliva, and, if one observation can be trusted, no paralysis of the inhibitory fibres of the pneumogastric.

No marked difference was observable between the two salts, except that the morphia salts seemed rather more potent than the corresponding codeia bodies.

The salts of deoxycodeia and deoxymorphia given by mouth or by subcutaneous injection in doses of a decigramme, produced in adult cats, almost immediately after exhibition, a series of convulsions much more epileptic in character than tetanic. In one case there was a distinct rotatory movement.

In a few minutes these convulsions passed away, leaving the animal exhausted and frightened. Then followed a stage of excitement with dilated pupils and flow of saliva, very similar to the effects of the tetracodeia and tetramorphia salts, but less marked.

Doses of half a decigramme given to adult cats produced the stage of excitement only, without the convulsions.

In no case, with any specimen of product, has vomiting been witnessed.

Trials with rabbits gave only negative results. Like the tetracodeia and tetramorphia products, the deoxycodeia and deoxymorphia salts appear to paralyse the inhibitory fibres of the pneumogastric.

No marked differences could be observed between the hydrochlorates and hybromates of deoxycodeia or deoxymorphia.

CHEMICAL AND PHYSICAL ANALYSIS OF SUGAR.*

M. Payen's Process.

This process is based on the insolubility of sugar crystals in alcohol saturated with pure sugar, whilst many foreign matters are soluble in this liquid. The following is the mode of operating:—

An average sample of sugar to be analysed is rubbed lightly in a mortar, so as to break the lumps without

* Matthiessen and Wright, *Proc. Roy. Soc.*, vol. xviii., p. 88.

* *Saccharimetrie Optique, Chimique, et Melassesimetrique.* By L'Abbé Moigno.

injuring the crystals. 10 grms. of this sugar are weighed, and placed in a tube about 15 m.m. in diameter, and 30 centims. in length; then about 10 centims. of absolute alcohol are added, to eliminate the 2 or 3 per cent of water which the raw sugar may contain. After shaking the tube it is allowed to settle, and the alcohol decanted. There is then poured into the tube 50 centims. of the test-liquor, which is prepared in the following manner:—

To 1 litre of alcohol of 88° is added 50 c.c. of acetic acid of 7°; in this liquid there is dissolved 50 grms. of dry powdered white sugar. This quantity will saturate the liquid at a temperature of 59° F.; but in order that it may remain saturated in changes of temperature, a string of white sugar-candy crystals is suspended in the vessel which contains the liquor. The solution thus prepared is able to dissolve the uncrystallisable sugar and molasses, to decompose and dissolve sucrate of lime, without dissolving the crystals of pure sugar, because it is saturated with the latter.

(The saturated liquor was not quite all that could be wished in some changes of exterior temperature. M. Numa Grar has rendered it more exact by powdering sugar-candy in a mortar, mixing it with the test-liquor, and filtering it; then, on immediate use, it gave comparable results in the valuation of sugar to within a half per cent in the proportion of pure crystallised sugar extracted from the raw sample).

To continue: 50 centims. of this test-liquor are poured into the tube containing the raw sugar which has been washed with absolute alcohol and rapidly drained. The tube is shaken, and allowed to stand, and when the liquor has become clear it is decanted, and a fresh quantity of test-liquor poured in as first; it is again allowed to settle, and again the clear liquor is decanted. It is needful to make a last washing with alcohol of 96° or 98° to remove the saturated liquid interposed between the crystals. There only remains to place the sugar on a filter to dry, and weigh it. The difference between the weight of the sample submitted to analysis and that of the sugar remaining after the process indicates the foreign soluble substances which are mixed with the raw sugar. If the sugar contains insoluble substances, their quantity may be ascertained by dissolving all the remaining sugar in alcohol of 60°, filtering and weighing; the residue remaining on the filter will be the insoluble substances which the sugar contains.

M. Dumas has modified his process, and has rendered it more rapid and more sensitive by directly estimating the foreign soluble matters—the glucose and salts—by the excess of density which the test-liquor presents after the sugar has been washed in it above the density of the saturated solution used in the process. In the practice of this process an ordinary *alcoomètre* is all that is needed. The other parts of the process are nearly the same as M. Payen's.

The process is as under: To a litre of alcohol of 85° are added 50 grms. of acetic acid of 80°. To this liquid is added as much pure sugar as it will dissolve; it then marks 74° on the *alcoomètre*. On mixing a decilitre of this liquor with 50 grms. of sugar to be analysed, and filtering the liquid, to finish the valuation of the sugar it is only needful to plunge the *alcoomètre* into the filtered liquid; if it marks 74° again the sugar is pure; if it descends to 69° the pure sugar is 95 per cent; if it goes down to 64° the pure sugar is 90 per cent. Each degree lost on the *alcoomètre* corresponds to a degree of diminution in the richness of the sugar.

In very low-priced sugars, the variable nature of the impurities renders this latter analysis a little uncertain; but for sugars 87° to 100° (of saccharine value), which form the bulk of the sugars of commerce, the results accord with those of the polariscope. If the sugar contains sand or other insoluble matters, they must be taken account of.

In an important refinery in Paris, at Lille, in the most competent hands, in the Customs' Laboratory, and in that of the Sorbonne, this process has given similar results to the polariscope. In an average of twenty analyses made to determine the richness of a large delivery of sugars of three classes, the difference did not exceed one-thousandth, that is to say, it was *nil*. In a single trial it rarely varies 1 per cent, which is of no account, as we know that the sugars of commerce classed in the same type often differ as much as 8 or 10 per cent in richness.

M. Clerget acknowledges that the old process of M. Payen, although it does not indicate exactly the proportion of pure sugar contained in the raw sugar, gives useful results. He also allows that the process of M. Dumas is very important, not only from its exactitude, but still more so from the simplicity and promptitude of the method; at the same time, he calls attention to this important fact.

It is not sufficient to value the return in crystallisable sugar which may be obtained from saccharine juices—to prove the amount of pure sugar ($C_{12}H_{11}O_{11}$) which the juice contains—because, as is well known, up to the present time it has been found impossible to extract the whole of this, or even a quantity proportionately constant, because of other soluble substances contained in the juice.

Barreswill's Process.

We reproduce this process, although it has been considerably improved, because M. Barreswill was one of the first to attack the difficult problem of sugar analysis. His saccharimetrical process is founded on the following facts, discovered by M. Frommers:—

(1). That crystallisable sugar does not reduce the oxide of copper contained in an alkaline fluid.

(2). That it becomes able to reduce this oxide when treated with sulphuric acid, which, by a few minutes' boiling, transforms it entirely into glucose.

(3). The quantity of binoxide reduced is in proportion to the quantity of sugar employed.

When it is required to find the quantity of crystallisable sugar which exists in a liquid, to the exclusion of every other organic product, a standard alkaline solution of oxide of copper must be prepared. By bringing together sulphate of copper, neutral tartrate of potash, and caustic potash, a liquid of an intense blue colour is obtained, which, being filtered, will remain clear and limpid a long time. This solution is the test-liquor, the strength of which must next be determined by ascertaining how much of a solution made with a certain weight of pure dry sugar-candy, with the addition of some drops of sulphuric acid, is needed to decolour exactly a determined volume of it. The test-liquor being thus carefully standardised, a certain quantity of it is placed in a porcelain or glass capsule, and there is then added to it some very concentrated caustic potash, the object of which is to increase the density of the liquid, and render the after precipitation of the oxide of copper more rapid. Then, by means of a graduated burette, the acidified sugar solution is allowed to fall drop by drop into the heated (boiling) test-liquor. As soon as the two liquids are in contact, a yellow precipitate of hydrate of copper appears, which becomes red, and settles to the bottom of the capsule when it has reached the temperature of the liquid in which it is formed. In proportion as the operation advances, the colour of the test-liquor decreases in intensity, whilst the copper is precipitated in a state of protoxide. It is terminated when the solution is entirely decoloured. Then by reading on the burette the number of divisions which it has required to arrive at this limit, we obtain by means of a calculation the quantity of sugar contained in the liquid under examination.

The delicate part of the operation is to seize the point when the precipitation of the oxide of copper is complete. We may arrive at this (if the sugar solution is itself uncoloured) as well by the decolouration of the test-liquor as by the cessation of the formation of the yellow-coloured precipitate, which precedes the deposit of the oxide of copper. The latter is the only test when the liquid to be tested is itself coloured. An excess of sugar solution

added to the test-liquor after the separation of the oxide of copper is complete gives to the solution a brown colour, easily recognised, which results from the reaction of the hydrated alkalies on the glucose.

In cases where the sugar liquid of which the composition is required contains both crystallisable sugar and glucose, the proportion of the latter substance is determined by first making trial with a portion of the liquid brought to a known volume, before it has been submitted to the action of sulphuric acid; the glucose alone reduces the copper solution, which pure sugar leaves intact.

Another portion of the sugar liquid is afterwards boiled with sulphuric acid, so as to convert all the sugar into glucose; by means of a second assay made with the liquor thus modified we have the total weight of the glucose which it then contains; and deducting the weight of the pre-existent glucose obtained by the first operation, we have in the difference the amount of crystallisable sugar contained in the sugar solution (or rather the quantity of glucose which the crystallisable sugar was able to furnish by treatment with sulphuric acid).

When the sugar solution contains (before treatment with acid) only crystallisable sugar, the amount may be ascertained by this method in a quarter of an hour, within 2 or 3 per cent.

The chief fault of this process is that it is only applicable in cases of simple solutions of pure sugar, or of a mixture of pure sugar and glucose. If the sugar to be tested contains tartaric acid, dextrine, or sugar of milk, these substances will act nearly in the same way as crystallisable sugar, and may consequently be confounded with it. On the other hand, there is no doubt of the existence of some organic substances which will reduce the alkaline copper solution in the same manner as glucose itself; in consequence of which this process cannot be employed with absolute certainty, unless by previous experiments it has been proved that other organic substances do not exist in the sugar to be analysed, or that these foreign matters have been properly separated by some efficient method.

Fehling's Copper Liquor.

The improvements mentioned as having been made in Barreswill's process are chiefly in the preparation of the test-liquor, which is called after the inventor. It is prepared as follows:—

"Dissolve 40 grms. of crystallised sulphate of copper in 160 c.c. of distilled water; in a separate vessel which will hold 1 litre place 160 grms. of cream of tartar, 130 grms. of caustic soda, and 500 to 600 grms. of distilled water at the boiling point. The hot alkaline liquor thus obtained dissolves the tartrate of potash very rapidly. The solution of sulphate of copper is then added little by little, when all this salt is dissolved; the litre bottle is filled up with distilled water. The liquor thus obtained is kept in a ground-stoppered bottle."

To standardise the copper liquor:—

"Having provided the liquor as above, the exact standard of it is then determined—*i.e.*, the quantity of sugar which corresponds to a certain volume of this liquor; 10 grms. of pure sugar are dissolved in 80 to 100 grms. of water; 2 or 3 grms. of hydrochloric acid are then added, and by four or five minutes' boiling the sugar is completely converted into glucose. This solution is thrown into a litre bottle, which is filled with distilled water to the gauging point.

Each c.c. of this liquor represents 1 centigrm. of pure inverted sugar.

Place 25 c.c. of the copper liquor in a capsule, and raise to the boiling point, when by means of the graduated burette the normal sugar solution falls drop by drop into the boiling copper liquor, until a red precipitate of oxide of copper is formed. Suppose that 15 c.c. of the normal sugar solution have decoloured the tartrate of copper, as each c.c. represents 1 centigramme of sugar, it needs 15 centigrammes of inverted sugar to decolour 25 c.c. of Fehling's test-liquor. The standard is then represented by 0·15 grm. The process is thus applied to colonial sugar; 10 grms. of sugar are placed in a flask holding 100 c.c., which is then filled up with distilled water. Each c.c. of this liquid represents 0·1 grm. of raw sugar. This liquid is allowed to fall drop by drop, as before, into the vessel containing 25 c.c. of the boiling copper liquor. Suppose that it requires 30 c.c. of the sugar solution, representing 3 grms. of sugar, to decolourise the liquor; the standard of the copper liquor being 0·15 grm. the glucose is found by the following calculation:—

$$3 \text{ grms.} : 0{\cdot}15 \text{ grm.} :: 100 : x$$
$$x = 5 \text{ grms.}$$

There is then 5 per cent of glucose in the raw sugar.

Chemical Analysis in its Application to the Sugar Industry.—By M. Feltz.

We are induced to reproduce this clear and practical note because it brings to our notice two instruments used in the sugar industry of Germany—the saccharometer of Balling and the areometer of Brix, with which it is worth while to become acquainted.

When it is wished to value the yield of sugar in a saccharine substance, the ordinary process has been to determine first the amount of crystallisable sugar it contains by the saccharometer. Another weight of the saccharine substance is then burnt, and this furnishes the quantity of ashes. These two known, the return is calculated according to the saline method.

The saccharimetrical method does not require much time. The weighing of a sample is easy and rapid, because there is no need to weigh to a centigramme.*

It is not the same in the determination of the ash. Three-quarters of an hour must be allowed for the incineration of solid saccharine substances, and at least one hour and a half for the evaporation and incineration of a juice or a syrup with the necessary care. Further, incineration, to be carried out with facility, requires apparatus of particular nicety. For an easy method of analysis in the factory it must therefore be renounced.

The saline method is founded on this principle—that the quantity of molasses produced in the manufacture of beet-sugar is proportionate to the amount of salts existing in the saccharine substance.

Another method practised for some time in German sugar factories is based on this—that the quantity of molasses produced is sensibly proportionate to the sum total of the foreign matters contained in the substance, deduction made for the water and the sugar. I shall speak particularly of this process, the result of which is called *the co-efficient of purity*.

Balling graduated an areometer in such a manner that each degree marked upon it corresponded to one per cent in weight of pure sugar dissolved in water. When the areometer known in Germany as Balling's saccharometer,† or Brix's areometer, marks, for example, 15° in a solution of pure sugar, it signifies that in 100 parts of the solution there are 15 of pure sugar.

Juice or syrup from the factory is always a solution of sugar and foreign matters in water. When Brix's areometer is plunged in this solution, this instrument marks a certain number of degrees corresponding both to the sugar and foreign matters in the solution. If, now, by an observation on the polariscope, or by Barreswill's copper method, it is determined how much pure sugar is contained in the solution, it is easy to calculate the weight of the impurities. Suppose that a sugar solution marked 15° on the areometer of Brix, and that saccharimetrical observation indicates 12 per cent of sugar, to obtain the quantity of foreign matters which are found in 100 parts

* 16·350 grms. of pure sugar, combined with 100 c.c. of pure water, gives in Duboscq's instrument a rotation of 100°; therefore 1 centigramme will give the rotation of 0·60 c.; in fact, an inappreciable quantity.

† M. Brix corrected the scale on Balling's instrument, and it is his areometer that is universally used in Germany.

in weight of the solution, it will be sufficient to deduct 12 from 15. Thus of 15 parts of solid matter, 12 are sugar; in 100 parts there will be $\frac{12}{15}^{0} = 80$ parts of sugar, and the co-efficient of purity of this solution is 80. We may remark that by subtracting 15 from 100 we shall have the quantity of water in the sugar liquid.

Thus, two determinations, both quickly made, are sufficient to determine the sugar, the water, and the foreign matters. The determination of the foreign matters is, however, not quite perfect. We have supposed that a degree of Balling or Brix corresponds *exactly* to 1 per cent of any substance whatever, which is not strictly correct. It will be found that the weight of foreign substances is always *less* than that indicated; but practically this is of no importance. It is, besides, possible, by a series of experiments, to determine the co-efficient of correction for the areometer in this respect.—*The Sugar Cane.*

ON COLOURS FROM COAL-TAR.*

By HARRY N. DRAPER, F.G.S.

(Continued from p. 297).

To illustrate the manner in which the chemical method of separation is applied, we have arranged here some glasses in which benzol, aniline, and phenol have each been shaken with an acid and an alkali. You will observe that, in the case of benzol, it floats indifferently upon the surface of both acid and alkali; but that the aniline, while untouched by the alkali, is dissolved by and mixes with the acid. The behaviour of phenol is exactly the reverse of this, for the alkali dissolves, while the acid is without action on it. You see in this experiment a general outline of the method by which coal-tar is made to give up the different bodies which it contains. We must, however, pass with some rapidity into detail: and bearing in mind that we have here to do with but five constituents of coal-tar, speak of them one by one as they come before us in their aspect of sources of colour.

By far the most important of these is that which we have here, benzol. To obtain it, the coal-tar oil is distilled by steam heat, and all those portions which boil under 90° on the centigrade scale are collected. Pure benzol is a very volatile, inflammable fluid, of a peculiar odour, forcibly recalling that of coal-gas. It boils at 81°C. It is very much used in the arts as a solvent of india-rubber; and, under the name of *benzine collas*, we are familiar with its employment for the removal of grease stains. When cooled to about the freezing-point of water, it forms very beautiful crystals. This fact is sometimes taken advantage of to effect its separation from the other bodies which accompany it in coal-tar oil. I must ask you to remember, as this is the point from which all we have to say about the colour-giving matters of coal-tar diverges, that benzol was discovered in 1825 by Faraday, who found it as a product of the action of a high temperature on benzoic acid. It is, however, to Hofmann that we owe its recognition as one of the products of the distillation of coal. This discovery was made in 1845.

Much lower down in the diagram you will see the name of another body, aniline, and to this substance I musk ask your particular attention. Aniline was discovered in 1826, by Undervorben, who found that indigo gave it as one of the products of its distillation. It has been successively known by the names of "crystalline" and "kyanol," and received its present name from Fritzsche, who, obtaining it by a process only slightly differing from that of Undervorben, named it from *anil*, the Portuguese name of indigo. Aniline, as you see by the diagram, is one of the tar oil constituents; but, as it exists there in very small quantities indeed, it is fortunate that we are not dependent upon this source of it. It is to Zinin that we owe the knowledge of the simple relations between benzol and aniline, and the fact that the former can be converted into the latter with the utmost readiness.

On referring again to the diagram, we observe that the chemical composition of benzol is thus represented:—

$$C_6H_6.$$

Now, when benzol is mixed with strong nitric acid, a very violent action takes place, and an orange-coloured liquid is formed. When the orange liquid is poured into water, a yellow oil separates and falls to the bottom. This is nitro-benzol. The following equation represents the change which takes place:—

$$\underbrace{C_6H_6}_{\text{Benzol.}} + \underbrace{HNO_3}_{\text{Nitric acid.}} = \underbrace{C_6H_5NO_2}_{\text{Nitrobenzol.}} + \underbrace{H_2O}_{\text{Water.}}$$

Nitrobenzol differs remarkably from benzol in its properties. It is, as you see, heavier than water, and its odour is remarkably fragrant, resembling to a considerable extent that of oil of bitter almonds. It is, indeed, known in commerce as artificial bitter almond oil, and is used as a perfume for soap. But it is merely as a step in the process of change which benzol undergoes in becoming aniline that nitrobenzol now interests us. When it is submitted to the action of hydrogen in that condition which chemists call *nascent*, that is just at the instant of its liberation, all the oxygen of the nitrobenzol is removed in the form of water, and, two atoms of hydrogen being introduced, we get *aniline*.

$$\underbrace{C_6H_5NO_2}_{\text{Nitrobenzol.}} + H_6 = \underbrace{C_6H_7N}_{\text{Aniline.}} + 2H_2O.$$

The method of effecting this change, now universally adopted, is that of Béchamp, which consists in distilling the nitrobenzol with iron filings and acetic acid.

The fact that, under certain circumstances, and more particularly when heated with any substance capable of affording oxygen to it, aniline gave rise to colour, was long known; but no one seems to have attempted to fix any of these colours. It was Runge who first noticed the action of chloride of lime upon aniline; and as this was, perhaps, the earliest experiment in which aniline was seen to give colour, we may repeat it. Here is a solution of a salt of aniline, and you will see that when we add to it a weak solution of chloride of lime, a blue colouration is at once produced. It is important not to add too much of the chloride, for the very agent which produces the colour is most active in destroying it. But though a patent has, indeed, been taken out for making a colouring matter in this way, the process has, I believe, been abandoned, as it is not very practicable.

It is to Mr. W. H. Perkin that we owe entirely the first method by which dye was obtained from tar on an industrial scale. Mr. Perkin was, at the time—in 1856—a pupil of Dr. Hofmann, and was engaged in the endeavour to form, by artificial means, the valuable medicine, quinine. I need not stop to detail here the details of this investigation, but may just say that he was acting upon a compound of toluidine with bichromate of potash. He was, as he tells us himself, surprised to find that, instead of getting quinine, he obtained only a dirty reddish-brown precipitate.

Being, however, desirous to know something more of the nature of this, he tried another base, and was fortunate enough to select aniline. I do not think that unless Mr. Perkin had been a very persevering chemist, we should have been any nearer to coal-tar colours to-day than we were in 1856; for in this case the precipitate was of quite as unpromising appearance as the first; but when it was more carefully examined, he found it to contain a beautiful purple-colouring matter. Here was the first appearance of *mauve*. Now this action of bichromate of potash on aniline will, perhaps, be clearer to you if we make the experiment. Here is a solution of aniline, and we will add to it some bichromate of potash solution. This is, somewhat curiously, the very process which is even now adopted

* A Lecture delivered before the Royal Dublin Society.

in making mauve. This dirty greenish-black precipitate is collected, and dried; it used to be washed with coal-tar naphtha, which removed a troublesome, resinous substance, with which it is contaminated; but this has been given up, and the powder is now treated at once with dilute methylated spirit, which dissolves out the dye; next the spirit is distilled off, and the dye which remains in watery solution is precipitated by the addition of caustic soda; it is then collected on a filter, washed, drained, and dried. Here is some of this aniline purple; it is a solid mass, brittle, and has a very beautiful bronze-like lustre.

We shall have to speak of this property of some of the coal-tar dyes again, so we will not stop to notice it now. Mauve is not very soluble in water, but very readily indeed in alcohol. Its intensity of colour is very remarkable, as I shall be able to show you. Here is a large vessel of water, and we will add to it some mauve, in the proportion of only 1-10th of a grain to a gallon. You see, even with this small quantity, the colour is not only distinct but deep.

This beautiful colour—here is a piece of paper, on which we have fixed it by means of albumen—is so much used now that many of my hearers know, probably even better than I do, that it is one of the "fastest" of the coal dyes, bearing the action of light remarkably well.

Now we have so much before us, that, as regards the chemical constitution of mauve I must only stop to point out to you that it is really a product of the oxidation of aniline; the bichromate of potash giving its oxygen to the base, and itself becoming reduced to sesquioxide of chromium. But no sooner was it ascertained that the action did depend upon oxidation, than the patent office was flooded with specifications, in which it was sought to supplant that of Perkin by effecting the same end by different means. It would be only interesting to chemists were I to read the list of substances which appeared in these specifications, to frame which it would almost seem as if the text-books had been ransacked for bodies capable of giving up their oxygen to aniline. Among those which we may single out, as really practicable, is the process of Dale and Caro, in which chloride of copper is used instead of bichromate of potash.

It was, however, soon discovered that, though a substance might oxidise aniline, it would not necessarily produce mauve; and it was found that there were some reagents, as, for example, nitrate of mercury, tetrachloride of carbon, chloride of tin, &c., which, instead of a purple, gave a crimson colour with aniline.

The discovery of this fact was the earliest step in the history of what is now known as magenta.

Magenta is formed when oxidising agents of a less energetic character than chloride of lime or bichromate of potash act upon commercial aniline. I say, on commercial aniline, because it has been found that pure aniline does not give the colour at all; and it has been found that the impurity—if we may so call it—which is necessary to a successful result, is another body, the name of which we have here on the diagram, and which bears exactly the same relation to the coal-tar product toluol as aniline does to benzol. This toluidine is not put into the aniline for this purpose, but the benzol used for making aniline is selected at such a boiling-point as will ensure the presence of toluol—the mixture being then first formed into a nitro-compound, and finally heated with iron and acetic acid, furnishes the mixture of aniline and toluidine which constitutes the aniline of commerce.

The process which is invariably followed in this country for the manufacture of magenta is that of Medlock. It consists in heating the aniline for some hours with a saturated solution of arsenic acid. This process is effected in a large closed iron vessel set in a furnace and provided with a stirrer. Heat is applied, and the mass is examined from time to time, until the maximum of colour is produced. Water is then added, and steam blown into the apparatus to dissolve the crude dye. The solution is filtered, and common salt is added to it. This throws down the colouring matter, which is collected again, dissolved in hot water, and set aside to crystallise. The result is in the form of these beautiful crystals, which I owe to the kindness of Messrs. Brooke, Simpson, and Spiller.

I think I can show you the formation of magenta from aniline, if we use, instead of arsenic, another substance, which does not require so much time. Here we have some aniline, and if we mix with it a little chloride of mercury, or corrosive sublimate, it forms a somewhat thick, sticky liquid, which as I heat it slightly, becomes, first, thicker and pasty, and then melts. As soon as it begins to boil the colour comes, and goes on increasing in intensity. It has now become very deep indeed; and you will see this better if I add some alcohol to it, and then pour a few drops into this large jar of spirit. Observe how all the liquid is coloured in a moment.

Magenta, from a chemical point of view, is a salt of a base called rosaniline; and it is a very curious thing, that, while the base is as nearly as possible colourless, the salts are colours of such intensity. Here, for example, is an ammoniacal solution of this rosaniline, and if we add to it an acid—some acetic acid—you see how rapidly it becomes red. Even the carbonic acid of the air can effect this change. So soon as the ammonia evaporates from the liquid, which I have here upon a piece of white paper, we have the crimson colour produced. Or, like most experiments, this may be pleasantly varied if we substitute this white flower for the paper, and, having immersed it in the solution, warm it gently over the gas flame. See how quickly the rose of York becomes that of Lancaster. It has been shown by Dr. Hofmann that when magenta is what chemists call reduced, that is, deprived of part of its oxygen, it is converted into this brown substance, called *leucaniline*. I must not dwell upon this, but may show you that, though acids do not, in the case of rosaniline, develope colour with this substance, it is at once transformed into rosaniline if we give it back its oxygen. Here is a solution of leucaniline, and I will add to it some bichromate of potash solution, which is a very convenient way of getting oxygen into bodies. As we heat the mixture, you will observe the red colour of magenta is at once developed.

You are all as familiar as I am with the colour of magenta; but you see it looks very pretty here, as we have it fixed upon a surface of albumenised paper.

Magenta is now manufactured on an enormous scale, being, indeed, considered rather as a raw material from which other dyes are made than as a dye itself, though, of course, there is a large consumption for it in this way too. As an example of the extent of this manufacture, I may say that, in going over the works of Messrs. Brooke, Simpson, and Spiller, a few weeks since, I was informed that they make 12 tons of aniline weekly; and at the same factory I saw magenta crystallising from a tank which contained 30,000 gallons of its solution. This was certainly the largest tank in the place, but there were some twenty others of smaller dimensions.

(To be continued.)

NOTICES OF BOOKS.

Light Science for Leisure Hours. By RICHARD PROCTOR, B.A. Camb., F.R.A.S., Author of "The Sun," "Other Worlds than Ours," "Saturn," &c. London: Longmans, Green, and Co.

OUR newspaper press is each year becoming more scientific, supplying its numerous readers with explanations of the unaccustomed phenomena of Nature, or elucidating technical terms or processes pertaining to some matter of general interest. Mr. Proctor's latest work is a collection of several essays contributed by him from time to time to the various periodicals and the daily press. The main subjects are astronomical or mathematical, but apart from

their intrinsic interest, the articles will well repay perusal on the ground of their bearings politically and historically. Perhaps the most important papers are the first two, in which the phenomena of the aurora, and the variation of the magnetic needle, with their mutual remarkable occurrences, are considered. Here the author's style is very happy; the language is perfectly suited to the general reader, who is gradually led on to understand why spectroscopists have come to the conclusion that the light of the aurora is due to vapour rendered luminous by the passage through it of electrical discharges; while the various speculations as to the nature of the vapour with its peculiar, and, as yet, isolated spectrum, are carefully analysed. The nature of this spectrum is perhaps one of the most interesting scientific questions that have yet to be answered, because its elucidation will tell us also the substance of the zodiacal light, and of the phosphorescence which illuminates at times the nocturnal skies, all these yielding the same spectrum. Of his own views, Mr. Proctor says:—"When once we have reason—as in the case of the aurora we undoubtedly have—to associate electricity wirh any particular form of luminosity, we seem clearly justified in extending the explanation to the same form of luminosity wherever it may appear. I believe that the key to the whole series of phenomena lies in the existence of myriads of meteoric bodies travelling separately or in systems around the sun. They are consumed in thousands daily by our own atmosphere; they probably pour in countless millions upon the solar atmosphere; and, from what we know of their numbers in our own neighbourhood, and of the probability of their being infinitely more numerous in the neighbourhood of the sun, we have excellent reasons for believing that to them principally is due the appearance of the zodiacal light and the solar corona."

But it is not with such difficult questions that the reader has continually to grapple, for he can, if he pleases, study the fallacies and chances of the odds in the next or latest race, or the peculiarities and rules of the Oxford and Cambridge rowing styles; or again, if his taste be classical, spend an hour with his Homer in considering the genuineness of the description of the shield of Achilles, and find that here, too, has been deep reading, which has given rise to clear thought and happy expression.

CORRESPONDENCE.

THE PHOSPHATE SEWAGE QUESTION.

To the Editor of the Chemical News.

SIR,—If "Superphosphate" were practically acquainted with the manufacture of superphosphate of lime, he would scarcely ask why the native mineral phosphate of alumina is not directly converted into manure, for a solution of it in sulphuric acid does not set and become friable, but remains pasty—a dry pulverulent condition being a *sine qua non* in making artificial manures. The practice with some makers is to use an excess of sulphuric acid in dissolving calcium phosphates in order to ensure a perfect solution, and to dry up the excess of acid with gypsum, but, as "Superphosphate" has learnt from his own experiments, that lime precipitates the phosphates of iron and alumina, this *modus operandi* would be useless as applied to phosphates of alumina, and I cannot see otherwise than that it is an error in manufacturing superphosphates from coprolites (which contain phosphates of Al and iron), to so dry them up, for if the proper quantity of acid is employed, and the coprolites properly ground, the whole of the available phosphates will be dissolved, and the manure be in a good condition; whereas, in an excess of acid, we obtain a pasty product entailing much labour in drying with gypsum, besides the all but inevitable certainty of reducing some of the soluble phosphate. The condition, too, is never so fine as it should be, and where the superphosphate is sold on an analysis there is a loss of acid and labour which is not met by the higher (if any) results.

My opinion, with regard to phosphates of alumina is that if they were ground to as fine a degree as possible, and mixed with a small percentage of well-dissolved animal charcoal, they might be so distributed in the field with beneficial results. I have always found that superphosphate made from coprolites, with the addition of a small quantity of animal charcoal, are more friable, give better results, both on analysis and in the field, and do not become so "reduced" as those made from coprolites alone.—I am, &c.,

JOHN COX.

Nottingham Mills Company.

MISCELLANEOUS.

Liebig on Germany and France.—At a meeting of the Royal Bavarian Academy of Sciences, on the 28th of March, Baron Liebig spoke thus of the future relations between Germany and France:—"The Academy seizes this moment to declare openly that there exists no national hatred between the German and Latin races. The peculiar character of the Germans, their knowledge of languages, their acquaintance with foreign people, the past and present state of their civilisation, all tend to make them just toward other peoples, even at the risk of often becoming unjust toward their own, and thus it is that we recognise how much we owe to the great philosophers, mathematicians, and naturalists of France, who have been in so many departments our masters and our models. I went forty-eight years ago to Paris to study chemistry; a fortuitous circumstance drew upon me the attention of Alexander Von Humboldt, and a single word of recommendation from him caused M. Gay-Lussac, one of the greatest chemists and physicists of his time, to make to me a young man of twenty, the proposal to continue and finish with his co-operation an analysis which I had commenced; he introduced me as a pupil into his laboratory, my career was fixed after this. Never shall I forget the kindness with which Arago and Thenard received the German student, and how many compatriots, physicians, and others, could I not name who, like myself, gratefully remember the efficacious assistance afforded to them by French men of science in finishing their studies. An ardent sympathy for all that is noble and grand, as well as a disinterested hospitality form some of the most noble traits of the French character."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Polytechnisches Journal von Dingler, second number for May, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Contamination of Iodine with Cyanide of Iodine.—Dr. G. C. Wittstein.—The author first refers to the researches on this subject made by MM. Scanlan, Meyer, and Klobach, the latter of whom found, in a sample of iodine, a quantity of cyanide of iodine amounting to 15 per cent. We further meet here with the results of the anal of two samples, *a* and *b*—the first being iodine made in the

way, by M. J. Sticht, at New York; the second, another sample of iodine, from which the maker had tried to separate the iodide of cyanogen by means of sublimation. Of sample *a*, 10 grains were weighed off and rubbed up in a mortar, after addition of a few drops of alcohol, with 16 grs. of metallic mercury, until all the free iodine was combined with the metal; the mass was next treated with 1½ fluid ounces of water, and the residue insoluble therein collected on a previously-weighed filter, and this next gently dried at 50°. The result was that the material thereon weighed 23·125 grains; consequently the loss (iodide of cyanogen) was 2·875 grains (since 26−23·125=2·875); the quantity per cent of iodide of cyanogen in this sample, 28·75. The amount of iodide of cyanogen found in sample *b*, which was tested in the same manner, was found to amount to 56·875. The author observes that Dr. Herzog has found that when iodine, which contains iodide of cyanogen, is treated with metallic iron and water, there is formed a liquid which contains, in addition to proto-iodide of iron, also proto-cyanide of iron. When carbonate of potassa is added to this liquid, all the iron and cyanogen are precipitated and eliminated; and the iodide of potassium thus prepared is quite free from any cyanide of potassium, which, it need hardly be said, is a substance the presence of which should be most scrupulously avoided in a salt like iodide of potassium, which is internally used in large quantities as a medicament.

Presence of Baryta in Native Silicates.—Dr. G. C. Wittstein.—Many years ago, the late Professor Mitscherlich, while analysing several specimens of feldspar, found therein baryta, amounting in many cases, to 2½ per cent. The author relates that he analysed some fifty samples of native silicates, among which were ten specimens of feldspar (all minerals met with in Bavaria), six of which were found to contain baryta; the highest percentage of that base present amounting to 2·518 per cent, the lowest to 0·3222 per cent, whereby we should observe that in two of the six samples only traces of baryta occurred.

Adulteration of Fuchsine.—Dr. A. Ungerer.—There was given to the author a sample of fuchsine which, having been found insoluble in alcohol, was considered unfit for use. It turned out, on investigation, that this sample of fuchsine consisted of coarsely-ground-up sugar-candy soaked in a very strong solution of fuchsine, so as to exhibit the external physical appearance of that body.

Changes which Flour Undergoes when Kept for a Length of Time.—Dr. Poleck.—The author has instituted a series of researches with the view of ascertaining the cause of the difference exhibited by flour preserved in casks, and that kept in bags, the former of which often obtains a peculiar smell. The author found that the gluten of flour exhibiting that peculiar smell had been, in a great measure, converted into a soluble modification, whereby the flour had lost the capability of being converted into a good dough, the flour also having assumed a sour reaction. The author ascribes the cause of this change to want of a sufficient circulation of air through the mass of the flour kept in casks, the innermost flour in which was most sour and gave off the peculiar somewhat mouldy smell. It was also found that, with this change in the flour, coincides an increase of the albuminous compounds therein soluble in water.

American Journal of Pharmacy, June, 1871.

Omitting the papers and memoirs more particularly relating to pharmacy and pharmacognosy, this number contains the following original papers and essays relating to chemistry:—

Culture of Hops in the United States.—E. Kannal.—Among other particulars more especially bearing upon the amount of production and cultivation of this important article, the author states that he obtained, from 1 lb. of fair commercial hops, 1¼ ozs. of lupulin, from 1 lb. of fresh New York hops 1 oz, and from fresh Philadelphia hops ¾ oz., averaging 1 oz. from the lb., or 6¼ per cent. The smaller yield in the last two cases was due to the fresh condition of the hops. When packed in bales, hops are sometimes adulterated—the outside consisting of good hops, while the interior is filled with hops deprived of the lupulin, and sprinkled over with lycopodium and powdered resin to hide the fraud.

Note on Hydrocyanate of Morphia.—Dr. J. M. Maisch.—After first referring to the fact that, among the descriptions of morphia salts, as furnished by various chemists, the hydrocyanate is not enumerated; in Gmelin's "Chemistry," some double hydrocyanates are mentioned, but not the simple morphia salt, of which, as far as the author knows, nothing is known of its formation or properties. The following contain the results of the experiments as thus far obtained:—(1) A neutral solution of a morphia salt, even if diluted to the proportion of 1 : 1500 (1 grain in 3½ ozs.), yields, with a neutral soluble cyanide, a crystalline precipitate consisting of hydrocyanate of morphia. (2) After the crystals have separated, the filtrate, acidulated with nitric acid, yields no precipitate with iodo-hydrargyrate of potassium; the morphia hydrocyanate, therefore, if soluble at all, dissolves but very sparingly in water. (3) The solubility of morphia hydrocyanate appears not to be increased by an excess of the precipitant. (4) The precipitate is readily dissolved if the liquid is slightly acidulated by a mineral acid; it is likewise soluble in acetic acid. Hydrocyanic acid does not precipitate a neutral solution.

Detection of Turmeric in Powdered Rhubarb and Yellow Mustard.—Dr. J. M. Maish.—A small quantity of the suspected rhubarb is agitated for a minute or two with strong alcohol, and then filtered, chrysophanic acid being sparingly soluble in this menstruum. The brown yellow colour of the filtrate is due to the resinous principles of rhubarb mainly; if adulterated with turmeric, the tincture will be of a brighter yellow shade; a strong solution of borax produces, in both tinctures, a deep red-brown colour. If now pure hydrochloric acid be added in large excess, the tincture of pure rhubarb will instantly assume a light yellow colour, while the tincture of the adulterated powder will change merely to a lighter shade of brown red. The test is a very delicate one, and is based on the liberation of boracic acid, which imparts to curcumin a colour similar to that produced by alkalies, while all the principles of rhubarb soluble in strong alcohol yield pale yellow solutions in acid liquids. The same test, applied in the same manner, is also applicable to ground mustard seed. The seeds of *Sinapis alba* yield a powder of a yellow-grey colour, entirely distinct from the colour of yellow mustard met with in the trade. Agitated with alcohol, and filtered, a turbid solution is obtained, which assumes a bright yellow colour on the addition of the borax solution, and becomes colourless or whitish again on being supersaturated with hydrochloric acid. If the mustard be coloured with turmeric, the filtrate has a yellow tint, becomes brown-red by borax, and retains the colour on addition of hydrochloric acid. All the so-called yellow mustard of commerce which the author has had occasion to examine, whether ground in England or in the United States, contains turmeric, a practice which ought to be discountenanced; for, under the yellow colour imparted by turmeric, adulteration of mustard may be carried on to an almost indefinite extent, if strength be supplied by the addition of a little capsicum.

Testing Cochineal.—J. M. Merrick, jun., S.B.—The author takes 2½ grms. of the drug, previously ground to powder, and boils that quantity in a capacious narrow-necked flask, with 750 c.c. of distilled water, for one hour. The liquid is immediately filtered through dry paper-filters, and tested when cold in the following manner:—50 c.c. are measured off and poured into another flask of about 200 c.c. cubic capacity, and the measuring vessel rinsed with a definite quantity of water, say 10 to 15 c.c.; a weak solution of permanganate of potassa is then run in from a burette with a glass cock, the flask being well shaken after the addition of every 10 c.c. of the permanganate solution (this does not, as does solution of bleaching-powder, precipitate the colouring matter of the cochineal), so much is added as to change the colour of the cochineal solution to a very faint pink shading on yellow, but never reaching a full yellow; this pink shade should be persistent, that is to say, it should not turn yellow after standing for fifteen minutes. The principal points in this practically very good method are—The use of a weak solution of permanganate; to have a very faint pink colour as a standard of comparison; to let the liquids remain, after agitation, together ten to fifteen minutes before comparing them. The author concludes his paper by observing that very little can be told of the value of a sample of cochineal by a mere physical examination, while the frequent inconsistency between value and price is equally surprising, the author having known samples to differ 30 per cent in colouring power and only one or two cents per pound in price.

Revue des Cours Scientifiques de la France et de l'Etranger (double number), June 8, 1871.

This number does not contain any original papers bearing upon chemistry or allied sciences.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 9, 1871.

This number contains the following original papers and memoirs:—

Derivation of the Relation of the Heat of Gases under Permanent Pressure and Volume from the Mechanical Theory of Heat.—Dr. F. Mohr.—This paper, and the following lengthy essay by the same author—

Doctrine of Molecules—Are not suited for useful abstraction.

Determination of what might be not inaptly termed Chemical Longitude and Latitude—viz., the Exact Situation and Locality occupied by the CH_3 in Aromatic Compounds.—G. Gräbe.—Illustrated with diagrams.

Contribution to our Knowledge on the Sulpho-Nitrogen Acids.—A. Claus.—This lengthy paper contains the preliminary record of the results of the author's experiment on the mode of preparation and some of the properties of a compound which appears to have the formula $SO_3.NO_2K$. This is obtained by mixing together freshly-prepared solutions of sulphurous acid in strong alcohol and a concentrated solution of nitrite of potassa in water (prepared by passing a current of nitrous acid gas into a concentrated solution of carbonate of potassa). Since the compound, the formula of which is above-mentioned, is insoluble in alcohol, it is thrown down, along, however, with some nitrite of potassa, from which it is to be freed by cautious washing with a little cold water. The compound is very prone to decomposition also by heat, even below 100°. When treated with some water and peroxide of lead at a temperature not exceeding 40° to 45°, an intensely violet-coloured solution of trisulphoxy-azotate of potassa, $[NO.3(SO_3K)]$, is formed, which salt is obtained in solid state by cooling the solution down to below 0°.

New Series of Aromatic Hydrocarbons.—Th. Zincke.—The second instalment of a monograph on this subject, treating on the oxidation of diphenyl-methan and benzyl-toluol. Diphenyl-methan or benzyl-benzol, $C_6H_5---CH_2---C_6H_5$, is difficultly oxidised, and yields mainly benzo-phenon, $C_6H_5---CO---C_6H_5$. Benzyl-toluol, structural formula $C_6H_5---CH_2---C_6H_4---CH_3$, yields, by strong oxidation, among other products, an acid of the formula $C_{14}H_{10}O_3$; when the oxidation is less violent, an acid, $C_{14}H_{12}O_2$. The greatest portion of this part of the essay is devoted to the enumeration and description of a large number of salts of these acids.

Action of Sodium upon the Two Isomeric Monobromotoluols.—W. Longuinine.—The contents of this paper are essentially, by the author's own confession, parallel to those, and almost identical with the contents of a paper on this subject, recently published by Dr. Zincke. The main products of the action of sodium upon monobromotoluols are ditolyl, and a fluid body boiling at between 277° and 282°, $C_{15}H_{16}$.

Aceto-Sulpho Acid.—C. Bender.—The acid just named is, in free state, a colourless, syrupy liquid. The author describes a series of salts of this acid, among which we quote the following:—Aceto-sulphate of baryta, $(CH_3.CO.CH_3SO_3)_2Ba+H_2O$, crystallises, forming nacreous shining lamellæ; loses its water at 100°. Lead-salt, $(CH_3.CO.CH_3SO_3)_2Pb+H_2O$, has an acid reaction, crystallises, fuses at 140°, and is decomposed at 170°. Copper salt—

$$3[(CH_3.CO.CH_3SO_3)_2Cu]+4H_2O,$$

a bluish green-coloured salt, crystalline, and, like the other salts, soluble in water and dilute alcohol.

Quantitative Spectrum Analysis.—K. Vierordt.—An algebraico-physical paper.

Preliminary Communication on the Electrolysis of the Substituted Derivatives of Acetic Acid.—G. E. Moore.—The author represents the decomposition of pure cyan-acetate of potassium by electrolysis by the following formula:—

$$2\left\{\begin{matrix}CH_2CN\\|\\COOH\end{matrix}\right\}+H_2O=\left\{\begin{matrix}CH_2CN\\|\\CH_2CN\end{matrix}\right\}+2CO_2+H_2O+H_2.$$

The author is engaged in more accurately investigating the various products of this decomposition.

Short Notice on Isomeric Iodobenzoic Acids.—P. Griess.—The author communicates that some five years ago he prepared iod-salylic acid, obtained by the action of hydriodic acid upon sulphuric diazo-salylic acid. The new acid alluded to is a crystalline body, difficultly soluble in water, but readily so in alcohol and ether, and fusing at 152°.

Test for the Detection of Small Quantities of Sulphur present in Coal-Gas.—Dr. V. Wartha.—The author forms, first, before the blowpipe, in the loop of a platinum wire, a bead of pure soda, and next passes this bead over the edge of the gas flame, after which the bead is held in the interior of the flame in order to deoxidise the sulphates and sulphites of soda into sulphuret of sodium; the bead is then transferred to a porcelain basin, crushed, and some nitro-prusside of sodium added, whereby the smallest trace of sulphur will be detected. This reaction is fifty times more sensitive than that upon silver-foil; and the test can be performed in about three minutes, whereas Dr. Vogel's sulphur-copper reaction for this purpose takes four hours.

Les Mondes, June 22, 1871.

This number does not contain any original papers bearing upon chemistry or allied sciences.

Annalen der Physik und Chemie, von Poggendorff, No. 4, 1871.

This number contains the following original papers and memoirs:—

Pendulum Observations.—Dr. O. E. Meyer.—Illustrated with engravings.

Periodicity of the Heliographical Dispersion of the Sun's Spots.—Dr. F. Zöllner.

Weber's Compensated Magneto Meter for Measuring the Intensity of the Gas Magnetism.—Dr. F. Kohlrausch.

Refraction and Dispersion of the Light in the Chloride, Iodide, and Bromide of Silver.—W. Wernicke.—An algebraico-optical paper, an observation also applicable to the following paper.

Huyghen's Eyepiece.—Dr. J. B. Listing.

Combination of Sulphuric with Nitric Acid.—Dr. R. Weber.—The author caused the vapours of sulphuric anhydride to pass into very pure and highly concentrated nitric acid, care being taken to cool the flask containing this fluid very considerably by means of ice. By carefully experimenting, there is thus formed a crystalline substance, which, after having been drained by being placed on porous bricks, yields very deliquescent well-defined crystals soluble in water, thereby causing an elevation of temperature. This solution, on being tested with potassium iodide, only produces a very faint yellow colouration, thereby indicating that traces only of nitrous acid are present. The analysis, executed according to a method described here at length, but not presenting any new feature, led to the result that the formula of the body here alluded to is $4SO_3,NO_3,3HO$. In 100 parts, as found by experiment—Sulphuric acid, 66·22; nitric acid, 23·44; water, 11·25. As calculated according to the formula—Sulphuric acid, 66·40; nitric acid, 22·41; water, 11·19.

Construction of Filtering Apparatus According to Bunsen's Apparatus.—E. Zettnow.—This description cannot be understood without the reproduction of the engravings.

Appendix to my Paper "On the Influence the Concentration of Saline Solutions has upon the Electromotive Force.—Dr. L. Bleekrode.—The addition to a lengthy essay published by the author in this periodical some years ago.

Green Pigment of Leaves.—Dr. J. J. Müller.—A paper illustrated with engravings and treating on the spectrum phenomena exhibited by the leaves of various kinds of plants viewed in strong sunlight.

Critical Remarks on Dr. Andrews's Paper on the Ice Calorimeter.—Prof. R. Bunsen.

Observations on the Ice Calorimeter.—Dr. C. Bohn.

Observations on the Theory of the Oceanic Currents, as set forth by Dr. Witte.—A. Colering.

Microscopical Structure of Hailstones.—Dr. P. Reinsch.—A paper illustrated by engravings, and, as the immediately preceding and following, chiefly algebraico-physical as regards the contents.

Conduction of Heat in Layers of Liquids.—Dr. Despretz.

NOTES AND QUERIES.

Temperature of the Sea.—I have consulted Fownes, Miller, Watts, Berzelius, &c., but, though most of them give the composition of the water of the English Channel, none of them mention its temperature. By supplying this information in your next number you would greatly oblige.—THERMO.

Kelp Liquors.—I use wrought-iron pans for boiling down my kelp liquors, which average 50° T.: towards the latter stages of concentration, I find they act upon the iron rendering the salts black. Can you inform me of the cause, and if there is any remedy?—IODINE MANUFACTURER.

A Problem in Chemistry.—The following novel question is taken from the chemistry paper set at the preliminary examination of the Royal College of Surgeons, on June 22:—"I give you £2, or £2 10s. to purchase some chemicals and chemical apparatus. Give a list and price, as near as may be, of the various articles you would purchase."—M.C.

TO CORRESPONDENTS.

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No. 606.—FRIDAY, JULY 7, 1871.

ON THE GASEOUS AND LIQUID STATES OF MATTER.*

By THOMAS ANDREWS, M.D., F.R.S.,
Vice-President of Queen's College, Belfast.

THE liquid state of matter forms a link between the solid and gaseous states. This link is, however, often suppressed, and the solid passes directly into the gaseous or vaporous form. In the intense cold of an Arctic winter hard ice will gradually change into transparent vapour without previously assuming the form of water. Carbonic acid snow passes rapidly into gas when exposed to the air, and can with difficulty be liquefied in open tubes. Its boiling-point, as Faraday has shown, presents the apparent anomaly of being lower in the thermometric scale than its melting-point; a statement less paradoxical than it may at first appear, if we remember that water can exist as vapour at temperatures far lower than those at which it can exist as liquid. Whether the transition be directly from solid to gaseous, or from solid to liquid, and from liquid to gaseous, a marked change of physical properties occurs at each step or break, and heat is absorbed, as was proved long ago by Black, without producing elevation of temperature. Many solids and liquids will for this reason maintain a low temperature, even when surrounded by a white-hot atmosphere, and the remarkable experiment of solidifying water, and even mercury, on a red-hot plate, finds thus an easy explanation. The term spheroidal state, when applied to water floating on a cushion of vapour over a red-hot plate, is, however, apt to mislead. The water is not here in any peculiar state. It is simply water evaporating rapidly at a few degrees below its boiling-point, and all its properties, even those of capillarity, are the properties of ordinary water at 96·5° C. The interesting phenomena exhibited under these conditions are due to other causes, and not to any new or peculiar state of the liquid itself. The fine researches of Dalton upon vapours, and the memorable discovery by Faraday of the liquefaction of gases by pressure alone, finished the work which Black had begun. Our knowledge of the conditions under which matter passes abruptly from the gaseous to the liquid, and from the liquid to the solid state, may now be regarded as almost complete.

In 1822, Cagniard de La Tour made some remarkable experiments, which still bear his name, and may be regarded as the starting-point of the investigations which form the chief subject of this address. Cagniard de La Tour's first experiments were made in a small Papin's digester, constructed from the thick end of a gun-barrel, into which he introduced a little alcohol and also a small quartz ball, and firmly closed the whole. On heating the gun-barrel with its contents over an open fire, and observing from time to time the sound produced by the ball when the apparatus was shaken, he inferred that after a certain temperature was attained the liquid had disappeared. He afterwards succeeded in repeating the experiment in glass tubes, and obtained the following results:—An hermetically-sealed glass tube, containing sufficient alcohol to occupy two-fifths of its capacity, was gradually heated, when the liquid was seen to dilate, and its mobility at the same time to become gradually greater. After attaining to nearly twice its original volume, the liquid completely disappeared, and was converted into a vapour so transparent that the tube appeared to be quite empty. On allowing the tube to cool, a very thick cloud was formed, after which the liquid reappeared in its former state.

It is singular that in this otherwise accurate description, Cagniard de La Tour should have overlooked the most remarkable appearance of all, the moving or flickering striæ, which fill the tube when, after heating it considerably, the temperature is quickly lowered. This phenomenon was first described by myself in 1863, as it it is seen in carbonic acid, which has been partially liquefied by pressure, and afterwards heated a little above 31°. It may be observed on a larger scale and to great advantage by heating such liquids as sulphurous acid or ether in hermetically-sealed tubes.

The experiments whose results I am about to describe have occupied me for a period of fully ten years; they involved the construction of novel forms of apparatus, in which the properties of matter might be studied under varied conditions of temperature and pressure, such as had never been realised before. In my earlier attempts I endeavoured, as others had already done, to use the expansive force of the mixed gases which are disengaged in the electrolysis of water; and I was able in this way to obtain pressures of 150 atmospheres and even more in glass tubes; but the method was in many respects defective, and more than one dangerous explosion occurred, so that I eventually abandoned it.

In the apparatus finally adopted, the gas to be compressed is enclosed in a long glass tube, of which the greater part of the length, or about 450 millimetres, has a capillary bore, and the remainder, about 150 millimetres, an internal diameter of 2 millimetres. The free capillary end is sealed, while the gas in a pure and dry state is passing through; while at the other end the gas is confined by a movable column of mercury. The details of the method by which this is accomplished will be found in the Bakerian lecture for 1869, to which I must also refer for an account of the process by which the original volume of the gas at the freezing-point of water, and under one atmosphere of pressure was determined, and also the volumes of the same gas deduced from the observed measurements when it was compressed at different pressures in the capillary tube.

A conical protuberance on the capillary part of the tube, a little above its junction with the wider part, corresponded as nearly as possible with a hollow cone in a stout brass flange, the joint being rendered perfectly tight by careful packing. The body of the apparatus consisted of two

* Read before the Royal Institution of Great Britain, June 2, 1871.

cold-drawn copper tubes of great strength, to the ends of which four massive brass flanges were firmly attached. Two corresponding flanges or end pieces, each carrying a fine steel screw packed with great care, were bolted on the lower flanges. The success of the experiments depended greatly on the packing of this screw. It was effected by means of a number of leather washers, tightly pressed down and saturated *in vacuo* with melted lard. The apparatus was now filled with water; the flanges with the glass tubes, one containing the gas to be examined, the other air or hydrogen to act as a manometer or measure of the pressure, were bolted down upon the upper flanges of the copper tubes. The joints had always leather washers interposed; and when sufficiently tightened, they resisted any pressure which could be applied, even for an indefinite time. The two copper tubes were connected by a fine horizontal tube, so that the whole of the interior of the apparatus was in free communication. The pressure was obtained by screwing one or other of the steel screws into the water. I have recently had the apparatus constructed of iron and filled with mercury. As mercury is much less compressible than water, the same length of screw produces a greater pressure on the interior of the apparatus, even with a larger cavity. There are other advantages in this form of the apparatus which I hope will facilitate future research. The objection to it is its extreme sensitiveness to changes of temperature, so that a variation of $\frac{1}{100}$th of a degree alters the internal pressure by several atmospheres.

In the actual experiments the gas under examination does not come into view till it has entered the capillary tube, and is exposed to a pressure of thirty or forty atmospheres. The limit of the pressure which can be obtained has hitherto been the capacity of resistance of the glass tubes to bursting. Fine thermometer glass tubes of white glass will frequently burst when exposed to a pressure of little more than 100 atmospheres; but green glass tubes of good quality are much stronger, and will easily bear a pressure of 300 atmospheres. One of the strongest forms of glass capillary tube for resisting internal pressure is obtained by drawing out a thick green glass tube, heated to softening, till it becomes so fine as to be flexible. Tubes of this kind can easily be drawn out at the blowpipe table, and obtained of very uniform bore. I have compressed air in such tubes to $\frac{1}{800}$th of its ordinary volume without bursting the tubes.

Two rectangular brass cases, closed before and behind with plate-glass, surround, one the manometer, and the other the tube containing the gas to be examined, and allow them to be maintained at any required temperature by the flow of a stream of water. The manometer was maintained as nearly as possible at the temperature of the apartment; the tube containing the gas, on the contrary, was maintained at different temperatures, according to the object in view. The following observations, published in 1863, contain the results of my earliest experiments on this subject:—"On partially liquefying carbonic acid by pressure alone, and gradually raising the temperature at the same time to 88° F., the surface of demarcation between the liquid and gas becomes fainter, loses its curvature, and at last disappears. The space is then occupied by a homogeneous fluid, which exhibits when the pressure is suddenly diminished or the temperature slightly lowered, a peculiar appearance of moving or flickering striæ throughout its entire mass. At temperatures above 88° no apparent liquefaction, or separation into two distinct forms of matter could be effected, even when a pressure of 300 or 400 atmospheres was applied. Nitrous oxide gave analogous results."

The flickering striæ referred to can be admirably shown, as I mentioned before, in hermetically sealed tubes of strong glass, partially filled with such liquids as sulphurous acid or ether. The liquid must in the first instance be heated a few degrees above what I have designated the "critical" point. The appearances exhibited by the ascending and descending sheets of matter of unequal density are most remarkable, but must be seen in order to be understood. They only occur in this striking form in fluids heated a little above the critical point, and are produced by the great changes of density which slight variations of pressure or temperature produce in this case. They are always a clear proof that the matter in the tube is homogeneous, and that we have not liquid and gas in presence of one another. These striæ are, in short, only an extraordinary development of the movements seen in ordinary liquids and gases when they are heated from below. The experiments to be immediately described will explain their great intensity above the critical point.

When the temperature falls below the critical point, the formation of a cloud indicates that we have now heterogeneous matter in the tube, fine drops of liquid in presence of a gas. We must take care, however, not to suppose that a cloud *necessarily* precedes the formation of true liquid. If the pressure be sufficiently great no cloud of any kind will form.

I now proceed to describe the general results of the experiments upon carbonic acid. If a certain volume of carbonic acid at the temperature of 13·1° and under a pressure of one atmosphere be exposed to a gradually-increasing pressure, its volume will steadily diminish, but at a faster rate than according to Boyle's law, till at the pressure of 48·9 atmospheres its volume is reduced to about $\frac{1}{81}$ of the original volume at one atmosphere. Liquefaction now begins and continues with very slight augmentation of pressure, the necessity for which I traced to the presence of a minute quantity of air (about $\frac{1}{800}$th part) in the carbonic acid. On augmenting the pressure after liquefaction, the volume slowly diminished, but at a much faster rate than in the case of ordinary liquids. Later experiments carried to much higher pressures have fully confirmed this result. At 21·5° similar results were obtained, but a pressure of nearly 60 atmospheres was required before liquefaction began.

At 30·9° C., or 87·7° F., the critical point of temperature is reached. It is the temperature at which liquid ceases to be formed under any pressure. At a temperature a little below this point the surface of separation between liquid and gas becomes very faint and loses its curvature, the density and other physical properties of the liquid and gas being now identical and the tube filled with homogeneous matter. If the temperature and pressure be kept steady, no evidence of heterogeneity will be obtained by optical tests under the most varied conditions of volume.

If we now follow the course of a given volume of carbonic acid gas at 31·1°, or 0·2° above the critical point, we shall find that its course resembles that of the gas at lower temperatures till the volume is reached at which liquefaction might be expected to begin. A rapid but not (as in the case of the formation of liquid) abrupt fall then supervenes, after which the carbonic acid undergoes a slow diminution of volume as the pressure augments. The curves, which are here exhibited as they were represented in the Bakerian lecture, illustrate very clearly these statements. We have thus carbonic acid at 0·2° above the critical point, and at a pressure of 73 atmospheres behaving very nearly as if it liquefied. At this pressure an augmentation of only $\frac{1}{31}$th of the entire pressure diminishes the volume of the carbonic acid to about one-half. Yet during the whole of this fall, no evidence of heterogeneity, or of two states of matter present together in the tube, could at any period be obtained. Carbonic acid at this temperature of 31·1°, and under a pressure of 75 atmospheres, behaves much more as a liquid than as a gas when the pressure is either augmented or diminished; yet it never exhibits under any conditions the characteristic properties of the liquid state; that is to say, no surface of separation is formed by change of pressure, nor will it collect into drops and form a cloud.

At 32·5° the fall, when liquefaction might be expected, is less abrupt than at 31·1°; and at 35·5°, although still manifest, it is further reduced. At 48·1° the fall shown at

lower temperatures can no longer be distinctly observed, and the curve representing the change of volume approximates to that of a perfect gas. There can be little, if any, doubt that at a higher temperature carbonic acid would behave under augmenting pressures nearly as nitrogen or hydrogen.*

I have frequently exposed carbonic acid, without making precise measurements, to much higher pressures than any of the foregoing, and have made it pass without break or interruption from what is regarded by every one as the gaseous state, to what is, in like manner, universally regarded as the liquid state. Take, for example, a given volume of carbonic acid gas at 50° C., or at a higher temperature, and expose it to increasing pressure till 150 atmospheres have been reached. In this process its volume will steadily diminish as the pressure augments, and no sudden diminution of volume, without the application of external pressure, will occur at any stage of it. When the full pressure has been applied, let the temperature be allowed to fall till the carbonic acid has reached the ordinary temperature of the atmosphere. During the whole of this operation no breach of continuity has occurred. It begins with a gas, and by a series of gradual changes, presenting nowhere any abrupt alteration of volume or sudden evolution of heat, it ends with a liquid. The closest observation fails to discover anywhere indications of a change of condition in the carbonic acid, or evidence, at any period of the process, of part of it being in one physical state and part in another. That the gas has actually changed into a liquid would, indeed, never have been suspected, had it not shown itself to be so changed by entering into ebullition on the removal of the pressure. For convenience, this process has been divided into two stages, the compression of the carbonic acid and its subsequent cooling; but these operations might have been performed simultaneously, if care were taken so to arrange the application of the pressure and the rate of cooling that the pressure should not be less than 76 atmospheres when the carbonic acid had cooled to 31°.

We are now prepared for the consideration of the following important question. What is the condition of carbonic acid when it passes, at temperatures above 31°, from the gaseous state down to the volume of the liquid, without giving evidence at any part of the process of liquefaction having occurred? Does it continue in the gaseous state, or does it liquefy, or have we to deal with a new condition of matter? If the experiment were made at 100°, or at a higher temperature, when all indications of a fall had disappeared, the probable answer which would be given to this question is that the gas preserves its gaseous condition during the compression; and few would hesitate to declare this statement to be true, if the pressure were applied to such gases as hydrogen or nitrogen. On the other hand, when the experiment is made with carbonic acid at temperatures a little above 31°, the great fall which occurs at one period of the process would lead to the conjecture that liquefaction had actually taken place, although optical tests carefully applied failed at any time to discover the presence of a liquid in contact with gas. But against this view it may be urged with great force, that the fact of additional pressure being always required for a further diminution of volume is opposed to the known laws which hold in the change of bodies from the gaseous to the liquid state. Besides, the higher the temperature at which the gas is compressed, the less the fall becomes, and at last it disappears.

The answer to the foregoing question, according to what appears to me to be the true interpretation of the experiments already described, is to be found in the close and intimate relations which subsist between the gaseous and liquid states of matter. The ordinary gaseous and ordinary liquid states are, in short, only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid, the transition we have seen may be accomplished by a continuous process, and the gas and liquid are only distant stages of a long series of continuous physical changes. Under certain conditions of temperature and pressure, carbonic acid finds itself, it is true, in what may be described as a state of instability, and suddenly passes, with evolution of heat and without application of additional pressure or change of temperature, to the volume, which by the continuous process can only be reached through a long and circuitous route. In the abrupt change which here occurs, a marked difference is exhibited, while the process is going on, in the optical and other physical properties of the carbonic acid which has collapsed into the smaller volume, and of the carbonic acid not yet altered. There is no difficulty here, therefore, in distinguishing between the liquid and the gas. But in other cases the distinction cannot be made; and under many of the conditions I have described it would be vain to attempt to assign carbonic acid to the liquid rather than the gaseous state. Carbonic acid, at the temperature of 35·5°, and under a pressure of 108 atmospheres, is reduced to $\frac{1}{350}$ of the volume it occupied under a pressure of one atmosphere; but if anyone ask whether it is now in the gaseous or liquid state, the question does not, I believe, admit of a positive reply. Carbonic acid at 35·5°, and under 108 atmospheres of pressure, stands nearly midway between the gas and liquid; and we have no valid grounds for assigning it to the one form of matter any more than to the other. The same observation would apply with even greater force to the state in which carbonic acid exists at higher temperatures and under greater pressures than those just mentioned. In short, the passage under great pressures from the liquid to the gaseous state may be effected by the application of heat without break or breach of continuity. That a marked change in the physical properties of the substance occurs during this process is no objection to its being continuous. If mercury as a liquid is opaque and as a gas is transparent, the red and translucent bromine, on the other hand, when heated above the critical point, becomes so opaque as almost to resemble a mass of resin. Frankland has shown that the flame of hydrogen becomes continuous when the

* These different modes of passing from the gaseous to the liquid state are admirably illustrated by a solid model constructed by Prof. J. Thomson, which was exhibited at the lecture. I have been favoured by Prof. Thomson with the following description of this model:—

"The model combines Dr. Andrews's experimental results in a manner tending to show clearly their mutual correlation. It consists of a curved surface referred to three axes of rectangular co-ordinates, and formed so that the three co-ordinates of each point in the curved surface represent, for any given mass of carbonic acid, a pressure, a temperature, and a volume, which can co-exist in that mass.

"In Dr. Andrews's diagram of curves, published in his paper in the "Transactions of the Royal Society for 1869," p. 583, the experimental results, for each of several temperatures experimented on, are combined in the form of a plane curved line referred to two axes of rectangular co-ordinates. The curved surface in the model is obtained by placing these curved lines with their planes parallel to one another, and separated by intervals proportional to the differences of the temperatures to which the curves severally belong, and with the origins of co-ordinates of the curves situated in a straight line perpendicular to their planes, and with the axes of co-ordinates of all of them parallel in pairs to one another, and by cutting the curved surface out so as to pass through those curved lines smoothly or evenly.

"The curved surface so obtained exhibits in a very obvious way the remarkable phenomena of the voluminal conditions at and near the critical point of temperature and pressure in comparison with the voluminal conditions throughout other parts of the indefinite range of gradually varying temperatures and pressures. This curved surface also helps to afford a clear view of the nature and meaning of the continuity of the liquid and gaseous states of matter. It does so by its own obvious continuity throughout the expanse to which it might be extended round the outside of the critical point in receding from the range of the points of pressure and temperature where an abrupt change of volume can occur by gasification or condensation. On the curved surface in the model, Dr. Andrews's curves for the temperatures 13·1°, 21·5°, 31·1°, 35·5°, and 48·1° centigrade, from which it was constructed, are shown drawn in their proper places. The model admits of easily exhibiting in due relation to one another a second set of curves in which each curve would be for a constant pressure, and in which the co-ordinates would represent temperatures and corresponding volumes. It serves generally as an aid towards bringing the whole subject clearly before the mind."

gas is burned under a pressure of 20 atmospheres, and these experiments have been since extended by the same able chemist and Lockyer. We must not, however, suppose that one intermediate state exists between liquid and gas; on the contrary, an infinite succession of intermediate states may truly be said to connect the liquid proper and the gas proper; in other words, the passage is continuous. When the critical point is attained, the density of the liquid and gas becomes the same, and the tube is filled with homogeneous matter.

As regards the question of the continuity of the solid and liquid states, it would be necessary, in order to establish this continuity, to obtain, by the combined action of heat and pressure, the solid and liquid of the same density and of like physical properties. To accomplish this result will probably require pressures far beyond any which can be reached in transparent tubes; but it may be possible to show by experiment that the solid and liquid can be made to approach to the required conditions.

ON A LAW IN CHEMICAL DYNAMICS.*

By JOHN HALL GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, F.C.S.

It is well known that one metal has the power of decomposing the salts of certain other metals, and that the chemical change will proceed until the more powerful metal has entirely taken the place of the other. The authors have investigated what takes place during the process.

The experiments were generally performed as follows:—72 c.c. of an aqueous solution of the salt of known strength, and at 12° C., were placed in a tall glass; a perfectly clean plate of metal of 3230 square millimetres was weighed and placed vertically in this solution without reaching either to the top or bottom; the action was allowed to proceed quietly for ten minutes, when the plate was removed, and the deposited metal was washed off. The loss of weight gave the amount of metal dissolved, and represented the chemical action.

The most complete series of results was with copper and nitrate of silver.

Nitrate-of-silver solution.		Copper dissolved.				
Proportional number.	Percentage of salt.	Actual weights.	Average.	Theoretical.	Difference.
1.	0·3541	0·0045, 0·0050	0·00475	0·00455	+0·0002
2.	0·7083	0·0135, 0·0140	0·01375	0·01365	+0·0001
3.	1·0623	0·0240, 0·0250	0·02450	0·02590	−0·0014
4.	1·4166	0·0420	0·04200	0·04090	+0·0011
5.	1·7705	0·0600	0·06000	0·05830	+0·0017
6.	2·1246	0·0785	0·07850	0·07900	−0·0005
7.	2·4788	0·0975	0·09750	0·09940	−0·0019
8.	2·8332	0·1230, 0·1230	0·12300	0·12280	+0·0002
9.	3·1873	0·1510, 0·1480	0·14950	0·14810	+0·0014
10.	3·5415	0·1680, 0·1670	0·16750	0·17490	−0·0074
11.	3·8956	0·1955	0·19550	0·20350	−0·0080
12.	4·2497	0·2170, 0·2285, 0·2310, 0·2200	0·22410	0·23360	−0·0095
14.	4·9580	0·2740	0·27400	0·29820	−0·0242
16.	5·6664	0·3270	0·32700		
20.	7·0830	0·4540, 0·4100	0·43200		
24.	8·4994	0·5400	0·54000		
30.	10·6240	0·6850	0·68500		
32.	11·3330	0·7100	0·71000		
40.	14·1650	0·8440, 0·9090	0·87650		
48.	16·9990	1·0690	1·06900		
60.	21·2460	1·3590	1·35900		
70.	24·7880	1·5800	1·58000		

In the earlier terms of this series, *twice the percentage of silver-salt gives three times the chemical action.* The close agreement of the observed numbers with those calculated on this supposition as far as the 9th term, is shown in the fifth and sixth columns. The law then breaks down, and after about 7 per cent the increased action is almost in direct ratio with the increased strength.

The position of the plate in the solution was found to make no difference to this 2-3 law.

Similar series of experiments were made with zinc and chloride of copper, zinc and sulphate of copper, zinc and nitrate of lead, iron and sulphate of copper, and other combinations; and in every instance where the solution was weak and the action simple, the law of three times the chemical change for twice the strength was found to hold good.

It was proved that the breaking down of the law at about 3·5 per cent of salt in solution was irrespective of the quantity of the liquid, or of the time for which the plate was exposed. With 72 c.c. of a 1·41 per cent solution of nitrate of silver the rate of action remained sensibly the same for as long as twenty-five minutes, notwithstanding the constant deposition of silver. This apparently paradoxical result is due to fresh relays of the original solution being brought up to the plate by the currents produced, and that period of time elapsing before any of the products of decomposition are brought back again in their circuit.

When it was perceived that within easily ascertainable limits the chemical action is the same for similar consecutive periods of time, experiments were made in far weaker solutions. It was only necessary to lengthen the time of exposure. It was thus found that the law of three times the chemical action for twice the strength of solution holds good though at least eleven terms of the powers of two; in fact, from a solution that could dissolve 1 grm. of copper during the hour, to a solution that dissolved only 0·000001 grms., a million times less.

The manner in which the silver is deposited on a copper plate was examined, and the currents produced were studied. At first a light blue current is perceived flowing upwards from the surface of the plate, presently a deep blue current pours downwards, and these two currents in opposite directions continue to form simultaneously. A similar phenomenon was observed in every case where a metallic salt attacked a plate of another metal. The downward current was found to be a solution of almost pure nitrate of copper, containing about three times as much NO_3 as the original silver solution, while the upward current was a diluted solution of the mixed nitrates. Moreover, the heavy currrent took its rise in the entangled mass of crystals right against the plate, while the light current flowed from the tops of the crystalline branches. It was evident that when the fresh silver was deposited on these branches, and the fresh copper taken up from the plate, there was not merely a transference of the nitric element from one combination to another, but an actual molecular move of it towards the copper plate, producing an accumulation of nitrate of copper there, and a corresponding loss of salt in the liquid that is drawn within the influence of the branching crystals. Hence the opposite currents.

The amount of action in a circuit of two metals and a saline solution must have as one of its regulating conditions the conducting-power of that solution. It appeared by experiment that a strong solution of nitrate of silver offers less resistance than a weak one; and it was also found, on adding nitrate of potassium to the nitrate of silver, and its power of attacking the copper plate was increased; that the augmentation of the foreign salt increased the action still further; and the 2-3 law holds good between two solutions in which both the silver and potassium salt are doubled, though it does not hold good if the quantity of foreign salt be kept constant. Similar results were obtained with mixed nitrates of silver and copper.

While these later experiments offer an explanation of the fact that a solution of double the strength produces more than double the chemical action, they do not explain

* Abstract of a paper read before the Royal Society, June 15, 1871.

why it should produce exactly three times the effect, or why the ratio should be the same in all substitutions of this nature hitherto tried. The simplicity and wide range of the 2-3 law seem to indicate that it is a very primary one in chemical dynamics.

ON THE

DETERMINATION OF AVAILABLE CHLORINE IN BLEACHING POWDER.

By GEORGE LUNGE, Ph.D., F.C.S.

IN the last issue of the CHEMICAL NEWS there is, reprinted from the *American Chemist*, a paper by Mr. Herreshoff, describing a new method for the determination of available chlorine in bleaching powder. This method is founded on the well-known reaction between potassium bichromate and stannous chloride. I have nothing to say against its principle, and it may very likely yield accurate results in practice. But it must suffer under the disadvantage common to all volumetric methods based upon the application of stannous chloride, viz., the change which the solution of the latter undergoes so rapidly that it requires to be re-standardised for every new series of tests. This alone would be a drawback to the general introduction of Mr. Herreshoff's plan, but apart from it, the *raison d'être* which its author gives for the new method, and without which it does not seem to be called for at all, is, in my opinion, contrary to facts. He finds "the methods now in general use inconvenient, and, unless executed with the utmost care, liable to much inaccuracy," and he alleges against Penot's arsenic method (the only one he quotes, and certainly the best) several disadvantages. Now this method, as modified by Mohr, is so extremely easy of execution, quick and accurate that I believe most chemists will require strong reasons for inducing them to give it up for Herreshoff's or any other method. The disadvantages, however, which Mr. Herreshoff enumerates do not at all exist in fact, as I shall prove *seriatim*.

He says: "arsenious acid is with difficulty purified, and there is no convenient method by which to test its purity." It is, perhaps, not very pleasant work to re-sublime arsenic, but not at all difficult; besides, it can be easily avoided; at least I have never experienced any difficulty whatever in obtaining perfectly pure arsenious acid from the dealers in pure chemicals. Nothing, again, is more convenient than to test for its purity; heat (of course under a protecting hood) a little of the arsenic in a porcelain capsule, covered with another, and remove the second capsule when a little sublimate has been formed. If this sublimate shows no reddish tint, but is of a pure white, there are no sulphides in the arsenic, as they are more volatile than the arsenious acid, and sublime first. Then continue to heat till all arsenic is volatilised, and convince yourself that no fixed residue is left.

He says, further: "The standard solution of sodic arsenite is tedious to prepare, from the fact that it requires a long time for complete solution of the required amount of arsenic in sodic carbonate solution." This I do not understand at all. If the arsenic is finely pulverised, and if the quantities of sodium carbonate and water as prescribed in the usual text-books (say Fresenius or Mohr) are employed, I have always found that a few minutes after the liquid was fully boiling the arsenic was completely dissolved. It need then only be left to cool, and filled up to the required volume, and the standard solution is ready.

Lastly: "This solution will not keep with certainty for any length of time, and is newly standardised only with difficulty." It is well-known that Mohr has found out the cause of the arsenite solution sometimes becoming oxidised, viz., the presence of oxidisable sulphur compounds in the arsenic or the sodium carbonate employed. If such are avoided, and nothing is easier, then the arsenite solution keeps good for years. Mohr mentions that he found it unchanged after four years. I, for my part, have never had an opportunity of trying it for such a long period, as my stock of solution never lasted more than a few months at a time, but for some time I made a regular practice of testing the very last portion of the standard solution, which was kept in a large sized bottle, standing with its mouth upwards, and exposed to the light, and I never found the standard in the least changed. Nor can I see any trouble in re-standardising. I do it by means of iodine solution which has been first standardised itself with a small quantity of pure arsenic. I prefer, in opposition to Mr. Herreshoff, to run the arsenite solution into the iodine solution, as this more nearly corresponds to the operation in actual bleaching powder testings. In these the end of the reaction is tried on a piece of filtering paper moistened with a solution of starch containing a little potassium iodide. I find that the brown spots produced by the testing vanish again in a day or so, and the same paper, spread on a large porcelain crucible cover and kept from dust, lasts scores of times over again.

These are all the objections Mr. Herreshoff makes against Penot-Mohr's method, and I think they all fall to the ground. So far this method must be considered not only one of the best, but also the easiest and simplest for bleaching powder estimations.

ON COLOURS FROM COAL-TAR.*

By HARRY N. DRAPER, F.G.S.

(Continued from vol. xxiii., p. 308).

Now the quantity of crimson dye which is given by coal is, if we consider the question of weight only, by no means large. Here is a block of coal, which weighs 100 lbs., and here in succession are the quantities of tar, naphtha, benzol, nitrobenzol, aniline, and magenta which the 100 lbs. of coal give. See how sudden is the transition; notice how absurdly insignificant seems the quantity of magenta given by this large mass of coal. This smallness of quantity is, however, compensated to a great extent by the marvellous intensity of the colour. I think I can give you some idea of this. You will see, in the first place, that the quantity of wool which the magenta in this bottle will dye is nearly as large as that of the coal itself. But there is a very simple way of illustrating this in a striking manner. Here are two sheets of paper. One of them has been dusted over with some magenta, in fine powder, and the other with mauve. The colour-giving substances are there, but, at least to those of you who are at a distance, they are scarcely visible. But if we direct a stream of alcohol against the paper, you will see the latent colour develope itself in a very beautiful manner.

This experiment may be varied in a charming manner. Here you have a bouquet of apparently white flowers, on which I, before the lecture, dusted some of these dyes. On projecting a stream of alcohol upon them you will see, however, that they assume tints which, though I cannot say of them that each is exactly appropriate to the flower on which it appears, are at least sufficiently pretty.

In making magenta on the large scale which I have mentioned, there are large quantities of residuary products; and as it is important that these should be made as profitable as possible, they have been, of course, examined by the manufacturer. One result of this has been the discovery of the very beautiful orange colour which we have here, and though it is known in commerce as *phosphine*, chemists will recognise it better as a salt of chrysaniline.

This dye cannot be made at will, but is invariably formed in making magenta, and is separated during its purification. It gives, as you see, a very beautiful yellow orange tint, and is much used to produce scarlets, by first dyeing the

* A lecture delivered before the Royal Dublin Society.

silk or wool in magenta, and then passing it through a bath of phosphine.

Here is also a brown, which is one of these residual colours.

I spoke just now of magenta as being a raw material from which other dyes were produced, and we will now proceed to examine some of the means by which it is made to give blues and violets, and even greens. The most important process for making blues is that in which the magenta is heated with a further quantity of aniline. The process takes some time, and the mixture, which first becomes purple, changes finally to a very beautiful blue. This is what is known as "*bleu de Lyon*." It is, unfortunately, not soluble in water, and several methods have been adopted to make it so. The one most usually employed is exactly like that which is used with indigo for the same purpose, namely, treatment with sulphuric acid. A sulpho-acid is formed, and the result is a blue completely soluble in water. Here is a solution of this blue, the tint of which is very beautiful.

But, perhaps, the most interesting of the aniline blues is that called "Nicholson's blue." I cannot tell you how this is prepared, as the process has not been made the subject of a patent, but I can show you the blue itself. It is perfectly soluble in water, and what is most curious is, that, like salts of rosaniline, it is almost completely decolourised by alkalies. I have here an alkaline solution of this colouring matter which has been prepared before the lecture, and we will immerse this skein of silk in it, and then wash it well with water. If, now, we put the silk into water containing a little sulphuric acid, you will see the blue developed at once. This process of dyeing blue is now very extensively employed.

The fact that the combination of aniline with magenta gave rise to violets and blues, led Dr. Hofmann to suppose that other bodies might supply the place of the aniline. He found that this was actually the case, and that the bodies known to chemists as iodide of ethyl and iodide of methyl could be substituted for aniline with most successful results. This discovery has given rise to an entirely new series of colours, known in trade as "Hofmann's." The iodide of ethyl, or of methyl, is heated with the magenta, just as in the case of the aniline, and this beautiful violet is the first result. The tint obtained much depends upon the quantity of iodide used; becoming bluer, and even greener, as it is in excess. Perhaps the most interesting point in this process is, however, that if the quantity of iodide of ethyl is properly proportioned, a most beautiful green is the result. Here we have it in solution, and here is paper dyed in it. I think this is one of the most beautiful and most natural colours in the whole coal-tar series, though, where all are so beautiful, it is difficult to assign the place of honour to any one. The great advantage of this green is that it is at least as beautiful a colour by gaslight as by daylight. But it has the most remarkable property of being changed by exposure to heat. It differs, as I said, from the violent dyes only in containing more iodide of ethyl than they do. But this excess of iodide can be removed by heat; and if we pass this piece of paper, which has some of the green dye on it, over the flame of the lamp you will see an almost immediate change to violet. The degree of heat required is so near to that which chars the paper that I do not think this need be alarming to ladies who sit too near the fire. It might, however, be made the means of securing a charming variety in costume.

When I tell you that from the final residuum from these manufactures, when all the colour has been got out, especially from Dale's process for making violet, a very intense black is obtained, you will have formed some idea of the capability of aniline as a dye-producing material. This black is used largely in the manufacture of printing ink.

But we must now pass to the consideration of some of the other coal-tar constituents which produce colour, and I regret that our time is so short that we cannot speak of them, except in the briefest manner. The first of these which we shall notice is *phenol*. Here is a beautiful specimen of this body, which I owe to the kindness of Dr. Calvert of Manchester, who is the manufacturer of it in all the forms in which we find it in common. To you it is perhaps more familiar as *carbolic acid*; and its use as a disinfectant and as a remedy for toothache are sufficiently well known. We have only now to consider it as a producer of colour. At the beginning of this lecture I showed you the colour produced by phenol itself when a solution of chloride of iron is added to it. Had we time for the experiments we should find that this colour-giving property is shared by almost every compound of this body. One of the most interesting of these is *rosolic acid*. This body is procured by heating phenol with a mixture of sulphuric and oxalic acids. In commerce it is known as *aurine*. You see it here, in a fine specimen which Dr. Calvert has sent me, as a resinous mass having a greenish metallic lustre. When this substance is heated with ammonia it forms a very intensely coloured compound, which you will see produced when we add ammonia to the powdered acid in this dish. Aurine is used for dyeing this orange tint on silk, of which we have a specimen here. But if instead of merely adding the ammonia it is heated with rosolic acid in a closed vessel under pressure, there is found a new substance known as *peonine*, which was lately very extensively, and is still, I believe, to some extent, used as a dye for woollens. I ought here to mention that this dye has been said to have a specifically poisonous action, and to produce blistering where the fabrics dyed with it were worn next the skin. It is, however, easily recognised, Dr. Calvert tells me, by the bleaching action exercised on it by a solution of sulphurous acid. When peonine is heated with aniline, it is converted into the blue colour called "azuline," which at one time was manufactured on a very large scale, but has now been replaced by the blues I have already brought before you.

Then when phenol is heated with nitric acid a very violent action takes place, and the body called *carbazotic* or *picric* acid is produced. This body forms very beautiful crystals, and is much used in dyeing the beautiful yellow shade of which we have an example here, and also in giving green shades when combined with the blue colours. Picric acid, in its turn, gives with cyanide of potassium a crimson dye which, when converted into an ammonia salt, is identical with the beautiful colouring matter called *murexide*, a colour formerly obtained from animal sources.

Next we pass to *naphthaline*, a substance which is a positive trouble to gas manufacturers, and in choking up the mains becomes a fruitful source of that discontent which all of us express at one time or another in reference to our gas supply.

Naphthaline, too, has been made to give colours; and though I am passing over a subject which would afford material for at least an entire lecture, I can only call your attention to two colouring matters derived from it. One of these is called "Manchester yellow," and is much used in colouring soap; the other is a *naphthaline brown*. For specimens of both of these colours, I am indebted to the kindness of Messrs. Roberts, Dale, and Co., of Manchester, who are manufacturers of them.

One of the most cherished aims of those who have experimented on the products of the destructive distillation of coal has been the production from some of them of the colouring matter of *madder*. Some idea of the importance of this problem may be gathered from the fact that the total growth of this plant is estimated to amount to 47,500 tons, having a value of £2,150,000. England alone pays no less than £100,000 annually for the madder with which are produced the red, purple, and black printed calicoes for which she has become famous. All this money is paid to foreign countries, for England does not cultivate madder. But if we have not madder of our own, we possess coal, and every new use we can make of this becomes a new source of wealth. It is known that all the various tints, which, with different mordants, are given by madder,

are due to a substance called *alizarine*. Now it was discovered so recently as last year that this body, *anthracene*, which you see here as a coal product, and a specimen of which I hold in my hand, is capable, when treated in a suitable manner, of giving a colouring substance which is in every respect the same as the alizarine of madder. I regret exceedingly that we cannot now go into the details of this subject, but I introduce it to you notice because a lecture on the coloured derivatives of coal-tar would be wanting in the last and most interesting link which has been added to the subject were it to be altogether omitted.

I may, however, just say that this discovery is due to two German chemists, Messrs. Graebe and Liebermann, and that the manufacture of artificial alizarine is being carried on both by them in Germany, and by Mr. Perkin in England. Mr. Perkin has made a most important step on the industrial application of the discovery, for he has recently taken out a new patent in which is made a very important modification of the original process, which was too expensive to be of real commercial importance. It is interesting to find Mr. Perkin in 1856 the pioneer of the entire industry of the coal-tar colours, and now in 1870 intimately connected with that which will yet most probably prove to be the most important discovery which has yet been made in connection with it.

I may say, too, that at present there is a difficulty in the way of the application of this means of making alizarine, and this is the comparative scarcity of anthracene itself. Two thousand tons of coal give only 1 ton of anthracene; and until this quantity can be increased either by improved methods of operation, or until some other product of coal-tar—naphthaline, perhaps—can be converted into anthracene, the production of artificial alizarine will not attain to that commercial importance which is certainly in store for it.

I will now endeavour to show you how readily the dyes from coal-tar attach themselves to silk and wool, and thus illustrate experimentally the very simple process of dyeing with them. For silk and wools no mordants are used, as the affinity of these substances for the colours is very great.

Here are solutions of *magenta*, of *Hofmann's violet*, and of *picric acid*, and you see we have only to pass the skeins through them in order to dye them in a moment. But the colours do no possess this affinity for linen or cotton. I can show you this, I think. Here I have a pattern embroidered in silk on a cotton ground, and if we pass this through a solution of magenta you see it becomes uniformly coloured. But if we now leave it for a few minutes in dilute ammonia you will see that the dye is nearly removed from the linen, while the silk retains a beautifully deep tint.

You will naturally inquire how, then, the coal-tar dyes are applied to linen and cotton fabrics. Sometimes they are mordanted with tannin, which has the property of fixing the dye; but the usual plan is to print the colour in combination with white of egg—albumen—and then to coagulate the mixture by heat. Here is an egg which we have boiled hard, and if we put it into this warm solution of magenta, you will get a very good idea of the affinity of these colours for albumen. Now, you see it has become completely dyed. The consumption of albumen for this purpose is enormous, and is said to amount in one French province alone, where these dyeing and printing operations are carried on, to 300,000 pounds weight a year.

The coal-tar dyes have received many other applications besides those to dyeing and printing articles of wearing apparel. They have been employed to colour starch, and muslin stiffened with those starches looks very pretty indeed; they have been made the bases of printing and lithographic inks; are largely used in paper-staining; they are also employed in making coloured writing inks. Naphthaline yellow is used in giving a yellow tint to fancy soaps. Lastly, I may say that travellers have found rosaniline replacing rouge and henna on the cheeks and nails of Eastern ladies.

Before I leave a subject which has insensibly drawn me on much further than I intended, I must ask your attention to the beautiful bronze-like reflection which some of the aniline colours possess.

This appearance is common to all of them, to a greater or less extent; but I think the one which has it in the greatest intensity is the Hofmann violet.

Here is a large sheet of glass, over which we have spread some of this colour, which you see is of the most lovely purple by transmitted light, but reflects a tint like that of some varieties of tropical beetles, or the tail-feathers of the peacock. This fact has of course not escaped attention, and has been used in the decoration of several kinds of leather goods, of straw hats, and even of articles made of iron and steel. It is interesting to notice that the reflected colour is exactly the complementary of the colour transmitted.

It is not easy to obtain statistics of a manufacture like this of the coal-tar colours. I have already given you a few figures in reference to magenta, and to these I may now add, that the united gas works of Europe are capable of furnishing 53,000 cwts. of magenta, and that the estimated value of all the tar dyes made is about a million and a quarter pounds sterling annually.

You will see from the series of colours we have arranged here, that this black coal acts, so to speak, the part of a prism, and gives tints which extend from one end of the spectrum to the other; and, indeed, almost approach in brilliancy the natural spectrum.

It was once said of a celebrated divine, that he had not only exhausted his subject, but his hearers too; and as I do not wish you to say this of me, I will detain you no longer. There was an old story about a farthing's worth of iron, which, when made into chronometer springs, became worth a thousand pounds. In the industry we have been considering, we have a parallel to this. Dirt has been well-defined as "matter in the wrong place." This is just what coal-tar was before the discovery of these colours. When it could be made into mauve and magenta, it soon got into its right place, and has become a new means of employing labour, and a new source of wealth; for the almost useless tar gave a dye which, at the time of its discovery (it is cheaper now) sold, if not for its weight in gold, at the price of platinum.

I am painfully conscious of the imperfection of my attempt to lay before you this subject as I could have wished, but I cannot conclude without pointing out that these discoveries have arisen entirely from results obtained—not in trying to make dyes, but in studying chemistry for chemistry's sake. Hofmann, Perkin, Nicholson—all those whose names are intimately connected with the manufacture of colours from coal-tar—were students of pure chemistry. And tracing back from this large industry, which is slowly, but surely, changing the position of England from that of a colour-importing to that of a colour-exporting country, we come upon the name of him who, in discovering benzol, became the parent of it all. And it cannot be without encouragement to the student to note that the earnest study of Nature alone raised the book-binder's apprentice to the high position which Faraday occupied as a philosopher and teacher; that if Nature is in this respect like death,

> "Pulsat æquo pede pauperum tabernas regumque turres,"

and confers her favours alike on rich and poor, she yet is the truest type of perpetual life; that Faradays yet to come may, while sitting at her feet, and

> "Nourishing a youth sublime
> With the fairy-tales of science and the long results of time,"

look forward, like him whom we have lost, to the period when, to use the language of an elegant writer, "the sun of truth will arise in unclouded brilliancy, and place them in the enjoyment of that intellectual light which has ever been among the holiest aspirations of the human race."

EXAMPLES FOR PRACTICE IN QUANTITATIVE ANALYSIS.

By ALEXIS A. JULIEN.

(Continued from vol. xxiii., p. 290).

Example No. 6.—Analysis of Calcic Carbonate.

THIS is a pure precipitated *calcic carbonate.*

A. *Determination of* CaO.—Weigh out 1 to 1½ grms., throw into a beaker, moisten, add dilute HCl in excess, cover, heat to boiling until all CO_2 is expelled, add sufficient *ammonic oxalate* (Table II.), and then $(NH_4)_2O$ in slight excess, cover, and set aside over night. Decant carefully upon a filter, wash by decantation with boiling water, and transfer to the filter, taking care, before the addition of a fresh portion, to wait until the fluid has completely passed through the filter. If any particles of the precipitate cannot be rubbed from the sides of the beaker, dissolve them in a few drops of highly dilute HCl, add $(NH_4)_2O$, and transfer to the filter. The precipitate, when dried, is removed from the filter as thoroughly as possible, the filter burned on a platinum wire, and the whole treated in either of the following three ways:—

Conversion into CaO.—This method is especially applicable to small quantities of precipitate, under half a gramme, and consists in a strong ignition to bright redness over a blast-lamp, until the weight remains constant.

Conversion into $CaCO_3$.—The ashes of the filter are emptied into the hollow of the lid of the crucible, the lid is placed inverted on the crucible, and the latter heated, at first very gently, then more strongly, until the bottom reaches a very faint redness, and is so kept from ten to fifteen minutes, removing the lid from time to time. Cool, weigh, moisten with a little water, and test this after a time with a minute slip of *turmeric paper.* Should the paper turn brown, rinse off the slip of paper, throw in a small lump of $(NH_4)_2CO_3$, evaporate to dryness (best on the water-bath), heat to very faint redness, and weigh. If the weight has increased, repeat the same operation to constant weight.

Conversion into $CaSO_4$.—Moisten the precipitate with pure concentrated H_2SO_4, and ignite, or ignite it with pure $(NH_4)_2SO_4$, to a low redness, and repeat the operation to a constant weight, with the use of dilute H_2SO_4.

B. *Indirect Determination of* CO_2.—The apparatus required consists of a flask (50 c.c.), with a doubly perforated stopper, through which on the one side a tube passes down to the bottom of the flask, while its outer end is closed with a piece of rubber tubing and of glass rod. The tube which passes through the other perforation of the stopper is terminated just below the cork, while its outer end is connected, after a triple bend, with a tube filled with $CaCl_2$, which has not been over-ignited. The calcic carbonate is weighed in a small tube of just sufficient length to stand up at first in the flask. A sufficient quantity of dilute HCl is introduced into the flask, the tube inserted, the cork adjusted, and the whole carefully wiped and weighed. The tube is then upset, and the acid gradually allowed to decompose the carbonate. The liquid is then gently heated, the wax stopper is displaced by a tube filled with $CaCl_2$, air is drawn through the apparatus by means of an aspirator to the extent of six times the volume of the flask, the wax stopper is replaced, the whole cooled completely, wiped, and weighed. The loss in weight represents the CO_2.

Example No. 7.—Analysis of Limestone.

A. *Main Analysis.*—Dissolve 2 grms. in HCl and a little HNO_3, in a covered beaker, heat to boiling, transfer to a casserole, evaporate to dryness, moisten with HCl, dissolve in hot water, and filter.

(*a*). *Determination of* SiO_2.—Wash, dry, and ignite the residue, mix it with six parts of Na_2CO_3, fuse in a platinum crucible, soften the fused mass with water, acidify with HCl, evaporate to dryness, moisten with HCl, dissolve in hot water, filter, wash, dry, ignite, and weigh. Result, SiO_2.

(*b*). *Determination of* Al_2O_3 *and* Fe_2O_3.—Unite the filtrate from (*a*) to the main filtrate, add a little NH_4Cl and then $(NH_4)_2O$ in the slightest possible excess, boil a few minutes to expel the excess of $(NH_4)_2O$, filter rapidly, keeping the beaker and funnel carefully covered, wash thoroughly, dry, ignite, and weigh. But if the precipitate is bulky, re-dissolve in a little HCl, and divide the solution accurately; in one half, re-precipitate with a slight excess of $(NH_4)_2O$ as before, boil, filter, wash, dry, ignite, and weigh. Result, Al_2O_3 and Fe_2O_3 (and P_2O_5, if present in the limestone). In the other half, reduce the solution and determine the Fe volumetrically, as directed farther on, in Example No. 9.

(*c*). *Determination of* CaO.—Unite all the filtrates and washings from (*b*), heat to boiling, add sufficient ammonic oxalate (Table II.) and $(NH_4)_2O$ in slight excess, and then proceed exactly as in Example No. 6, A. Re-dissolve the calcic oxalate in HCl, re-precipitate with $(NH_4)_2O$ in excess, filter, wash, dry, and ignite. Result, CaO.

(*d*). *Determination of* MgO.—Unite the filtrates and washings from *c*, concentrate as much as possible, and precipitate the MgO exactly as in Example No. 2, A.

B. *Determination of* CO_2.—Employ one of the methods in Example No. 6, B.

C. *Determination of* S *and* P_2O_5.—Moisten 6 grms. of limestone with water, digest with HNO_3 until solution, evaporate to dryness, re-dissolve in HNO_3, dilute, filter, wash, and divide the solution.

(*a*). *Determination of* S.—In one half, dilute very largely, heat to boiling, add Ba_2NO_3 in slight excess, and proceed as in Example No. 2, B. Result, the entire amount of S in the limestone, occurring both as SO_3 and as S in the sulphides.

(*b*). *Determination of* P_2O_5.—To the other half of the solution add 100° c.c. of ammonic molybdate, stir, keep near the boiling-point several hours, and set aside over night in a warm place. Then decant on a ribbed filter, if the supernatant liquid is colourless, and transfer precipitate to filter by means of small portions of the filtrate. Rinse the beaker and wash the precipitate once with the diluted precipitant. Heat the filtrate and washings to boiling, add a little more of the precipitant, and set aside, to determine if any more P_2O_5 will be precipitated. Dissolve the precipitate back into the original beaker by pouring dilute $(NH_4)_2O$ through the filter. If a red residue of oxide of iron remains undissolved, pour dilute HNO_3, upon it, allow it to pass into the $(NH_4)_2O$ solution, acidulate that with HNO_3, boil, add more of the precipitant, and set aside as before, filter, and wash several times with the diluted precipitant, then dissolve the precipitate on the filter, and adhering to the beaker in as little as possible dilute $(NH_4)_2O$ into a small beaker. Add HCl almost to neutralisation, and from 1 to 10 c.c. of magnesia mixture, and continue as in Example No. 2, A.

D. *Determination of* SO_3.—Dissolve 5 grms. in a little HCl, evaporate nearly to dryness, dilute, filter, and wash. Heat to boiling, add sufficient $BaCl_2$ (Table II.), and continue as in Example No. 2, B. Result, the SO_3 actually occurring in the limestone. If the S in this amount be deducted from that found in C, *a*, the amount of S of the sulphides will be obtained.

E. *Determination of* H_2O.

(*a*). *Direct Determination.*—The apparatus required consists of a piece of hard glass tubing of large bore, connected at each end with a tube filled with $CaCl_2$. About 2 grms. of limestone are placed in a weighed platinum boat, the latter inserted in the long tube, a gentle current of air drawn through the whole apparatus by means of an aspirator, and the boat heated gradually up to an intense heat. The tube next the aspirator should be weighed before and after the operation, and its increase in weight denotes the amount of H_2O. The apparatus

may be improved by causing the air to pass through a bottle of concentrated H_2SO_4 before entering the apparatus; and by inserting another tube full of $CaCl_2$ as a guard, next the aspirator. If the two weighed soda-lime U-tubes (Example No. 6, B, *a*) are inserted after the weighed tube, and if the boat is heated with sufficient intensity, the amount of CO_2 may be determined in the same operation.

(*b*). *Indirect Determination.*—Heat 2 grms. in a weighed crucible, at 130° C., until the weight remains constant. The loss in weight denotes the amount of H_2O.

F. *Determination of Organic Matter.*—Fuse about 4 grms. of vitrified borax in a weighed platinum crucible, over a Bunsen burner, until the weight remains constant. Add about 1 grm. of limestone, weigh, and heat gradually to redness, until the contents of the crucible are in a state of calm fusion. Cool and weigh. The loss of weight denotes the CO_2+H_2O+ organic matter; and by deducting the amounts of the first two, already found, the amount of organic matter is obtained.

Example No. 8.—Determination of Copper in Ores.

Duplicate samples of the same ore, finely pulverised, should always be employed in the ensuing processes, in quantities from 1 to 3 grms., according to the richness or poorness of the ore.

A. *Roasting the Ores.*—This is especially necessary when the ore contains much sulphur or bituminous matter, but is always useful in insuring its subsequent decomposition. Put about 2 grms. of ore into a porcelain capsule and heat upon a tin plate, over the flame of a Bunsen burner, carefully stirring with a platinum wire, until no more fumes are evolved. This is usually ended in about ten minutes.

B. *Extraction of the Copper.*—Three methods are commonly employed.

(*a*). *Mohr's Method.*—Put about 2 grms. of ore into a casserole, add 10 c.c. concentrated H_2SO_4 and 10 c.c. concentrated HNO_3, cover with a convex cover, and heat carefully, almost to dryness, and until but slight fumes of H_2SO_4 are any longer evolved. Cool, add water, filter, and wash the siliceous residue.

(*b*). *Gibbs's Method for Sulphides.*—Mix the ore in a porcelain crucible with 3 to 4 times its weight of a mixture of 10 parts of KNO_3 and 14 parts of $KHSO_4$. Heat the whole slowly to low redness, add enough concentrated H_2SO_4 to convert all the K_2SO_4 into bisulphate, and heat again carefully until the contents of the crucible fuse to a liquid mass. Cool, add water, filter, and wash.

(*c*). *Storer and Pearson's Method for Sulphides.*—Mix 2 to 5 grms. with its bulk of powdered $KClO_3$ in a covered beaker, add HNO_3 of ordinary strength, rather more than sufficient to cover the powder. Heat to gentle ebullition, adding from time to time $KClO_3$, if needful, until the S is completely oxidised. Transfer to a casserole, add a quantity of strong HCl (rather larger than the quantity of HNO_3 first employed), evaporate to dryness, treat with water, boil, filter, and wash. It is always necessary to examine the siliceous residue on the filter for copper, before proceeding to the next process.

C. *Determination of* Cu.—Several methods may be employed, equally accurate in their results, although more skill and experience are usually necessary in the first three methods given below. Whatever method may be chosen, it is advisable for the student to render himself familiar with it, by the use of a copper solution of known strength, before applying it to the solution from the ore.

(*a*). *Precipitation with Zinc.*—Place the solution in a weighed platinum dish and throw in a piece of zinc, soluble in HCl without residue.* A porcelain dish, or casserole, may be substituted for the platinum, but it is best in that case to allow the zinc to rest upon a weighed slip of platinum foil. Add sufficient dilute HCl or H_2SO_4, if necessary, to produce a moderate evolution of H; or, if the latter is too brisk, add a little water. Cover the dish with a convex cover, keep up the evolution of H until the solution has become colourless, and rinse off the convex cover into the dish. Test a small portion for copper with HS water, and if no brown tint is produced, ascertain if any zinc remains undissolved, by feeling about with a glass rod and by adding HCl. Press the Cu together, decant the clear liquid, and wash rapidly by decantation with boiling water until the washings are quite free from acid. Decant the water as far as practicable, rinse with strong alcohol, dry at 100° C., and weigh. If a porcelain dish and platinum foil have been employed, transfer the foil and loose copper to a weighed porcelain crucible, dry, and weigh. Afterwards dissolve the Cu from the platinum dish, or foil, with HNO_3, wash, and again weigh the latter.

(*b*). *Precipitation with Iron.*—Place the cold, dilute, and nearly neutral solution in a porcelain casserole, and insert a clean sheet of iron or flat coil of pianoforte wire. The iron must be of such a material as dissolves uniformly (without ridges), and without the separation of black particles or flakes in weighable quantity. Control the evolution of gas as in the preceding process. As soon as the iron is coated with copper, add 20 c.c. of HCl, heat almost to the boiling-point, until the solution is free from copper, remove the iron, and wash the spongy coherent mass, by decantation (being careful to prevent it from falling to pieces, and rapidly, to prevent oxidation), first with boiling water, and afterwards with strong alcohol. Transfer to a weighed porcelain crucible, dry at 100° C., and weigh.

(*c*). *Precipitation with a Hypophosphite.*—The cold concentrated solution is treated with excess of a solution of an alkaline hypophosphite, and then gradually warmed on a water-bath to 80° or 90° C., care being taken to avoid loss by a sudden effervescence. The copper shortly separates in a coherent sponge. When the precipitation is complete, wash rapidly as in the preceding methods, dry, and weigh in a weighed porcelain crucible. Collect on a filter, wash thoroughly, dry, ignite, and weigh in a close crucible as oxide.

$$2CuSO_4+2NaPH_2O_2+4H_2O=$$
$$=2CuH+Na_2SO_4+SO_2+2H_3PO_4.$$
$$CuH \text{ boiled} = Cu+H.$$

—*American Chemist.*

* Lehigh and New Jersey zinc is generally free from lead.

ANALYSIS OF SUGARS.*

M. Peligot's Process.

THIS process is based on the essentially different action exercised by alkalies on the two sorts of sugars, *i.e.*, cane sugar and glucose (*sucre d'Amidon*, grape sugar, fruit sugar, &c.). Cane sugar combines with the alkalies; it forms with bases some compounds in definite proportions from which we may extract the sugar without the latter undergoing the slightest modification. Glucose will combine with alkalies just the same, but it gives birth to some compounds of such an emphemeral nature that it is impossible to keep them intact more then for a few moments. In fact, if a solution of glucose and potash is left to itself at an ordinary temperature, we may observe that the quantity of free potash contained in the liquor diminishes every day, and finally disappears altogether when the glucose is used in excess. The glucose is transformed, in fact, into one or more acids, which colour the liquid brown, and which form with the potash some neutral salts. The action which alkalies exercise slowly on the glucose at the ordinary temperature is developed instantaneously, if the solution of these bodies is boiled; in some minutes the transformation of glucose into these acids is complete.

* *Saccharimetrie Optique, Chimique, et Melassimetrique.* By L'Abbé Molgno.

The alkali which M. Peligot uses in his saccharimetrical analysis is lime. It is well known that pure water will only dissolve a thousandth part of its weight of lime, whilst sugar water will dissolve a considerable quantity, proportionate to the weight of sugar it contains. The compound which is formed when a solution of ordinary sugar is placed in contact with quicklime used in excess has been noted by M. Soubeiran. It is represented by the formula $2C_{24}H_{12}O_{12},3CaO$.

Thus, two equivalents of sugar, weighing 427 grammes, combine with 1050 grammes of lime, or three equivalents.

To analyse a raw sugar, weigh 10 grammes of it, and dissolve it in 75 cubic centimetres of water; add little by little to this solution, which is made in a glass or porcelain mortar, 10 grammes of sifted quicklime, rub it with the pestle 8 or 10 minutes, then throw the mixture on a filter to separate the undissolved lime (this base having been used in excess). In order to dissolve rapidly all the lime the sugar will take, it is better to pass the solution a second time through the filter. By means of a graduated pipette, take 10 cubic centimetres of the solution of saccharate of lime, add to it 2 or 3 decilitres of water—add to this liquid a few drops of the blue tincture of litmus, then neutralise it exactly with a standardised solution of sulphuric acid. This proof-liquor contains per litre 21 grammes of pure sulphuric acid, with one equivalent of water. A litre of this liquid saturates the quantity of lime dissolved by 50 grammes of sugar. The normal solution of sulphuric acid is first placed in a burette graduated into cubic centimetres, each of which is divided into ten parts.

The burette is filled up to zero; then the acid is dropped into the alkaline solution, which is kept agitated during the process, until the blue tint of the latter turns red under the influence of the last drops of the proof-liquor. Then by reading the divisions of the burette, the quantity of normal acid which has been required to attain this point of saturation, you obtain the quantity of lime, and thence the quantity of sugar contained in the solution of saccharate of lime; the total volume of this solution is known by means of a table prepared by M. Payen, for estimating the volume furnished by the given weights of sugar and of water.

For the analysis of ordinary raw sugar, the above is the process. M. Peligot states that he has proved that the proportion of glucose beet sugars contain is too small to be appreciated by the second operation about to be mentioned. But it happens sometimes that granulated glucose is introduced fraudulently into raw sugars intended for refining. To prove this adulteration, as well as to analyse molasses and the inferior raw sugars, which contain variable proportions of glucose, resulting from the modification of ordinary sugar, in consequence of the processes of extraction, &c., to analyse a product containing cane sugar and glucose, the process is as follows:—

After the first alkalimetrical valuation, place in a medicine phial one part of alkaline liquid, which heat in a water-bath to 212° F. for some minutes. If this liquid contains only the saccharate of lime produced by *pure* sugar, it becomes turbid by the action of heat, in virtue of the curious property which the calcareous compound possesses of coagulating, like the albumen of the egg, when heated to the boiling point. But this muddiness disappears on the liquid being allowed to cool, when it does not take a darker tint than it possessed before it was heated; and on submitting it to a second alkalimetrical trial after it has become cool, we get the same result as before. But if the sugar contains glucose, the solution, when heated in a water-bath, takes a brown tint; a brown deposit forms, which does not disappear on cooling, if there is a large proportion of glucose, and a strong odour is developed as of burnt sugar. Lastly, the second alkalimetrical determination shows a smaller quantity of lime than the first, which quantity will almost all belong to the pure sugar; the lime dissolved by the cold glucose having given birth to some neutral salts, on which the normal sulphuric acid liquor has no action.

In cases where pure glucose is to be analysed, after the cold liquor has been mixed with the lime, the first determination will show very nearly the same extent of alkalinity as with ordinary sugar; the second, made on a portion of the liquid heated to 212° F., will indicate the same quantity of lime as that which would have been dissolved in an equal volume of pure water; this quantity is very small—one decilitre saturates four cubic centimetres of the normal solution of sulphuric acid. Although the liquor may then be brown-coloured, the point of saturation may easily be seized, by taking care to add a little more of the tincture of litmus, and to stop at the moment when the solution, which becomes green, takes a clearer tint by the addition of the sulphuric acid. The trial of saccharine solutions is made by operating as above; the only precaution necessary is to work on liquids marking 6° to 8° on Baumé's areometer.

The juices of the cane and the beet are found naturally in these conditions; if more attenuated solutions are employed, it is at the risk of not being able to dissolve rapidly all the lime which they will take up; if they are more concentrated, they become too viscid for rapid filtration. The quantity of quicklime employed for these liquids should be such that it may be very nearly equal in weight to that of the sugar whlch is supposed to exist in the product to be analysed. This quantity is indicated approximately by the areometrical degree of the liquor.—*The Sugar Cane.*

REDUCTION OF NITRATE OF SILVER BY CHARCOAL.

By C. F. CHANDLER, Ph.D.

When solid nitrate of silver, either in crystals or sticks, is placed upon glowing charcoal, deflagration takes place, the silver being left in the metallic state, while binoxide of nitrogen and carbonic acid are evolved. The nitrate is fused by the heat of the reaction and sinks into the pores of the charcoal, and as each particle of charcoal is replaced by metallic silver, the structure of the original wood is preserved. With proper management, pieces of silver of any desired size can be prepared, showing the exact structure of the wood. A crystal of nitrate is placed on the end of a piece of charcoal, and the blowpipe flame is directed upon the coal near the crystal to start the reaction. When deflagration begins, crystal after crystal may be added. The nitrate fuses, passes down through the porous metal already reduced until it reaches the glowing coal, where it is reduced. I have prepared in this manner lumps of silver weighing an ounce or more, which exhibit most beautifully the rings of the wood.—*American Chemist.*

CORRESPONDENCE.

HISTORY OF THE AMMONIA PROCESS.

To the Editor of the Chemical News.

Sir—Dr. Angus Smith's last report, under the "Alkali Act," affords another proof that the ammonia process, originated by Chapman, Smith, and myself in 1867, has taken its place among the recognised resources of the laboratory. The time has now arrived for reviewing its history, partly with the object of getting justice done to its inventors, and partly with the object of preparing younger chemists for the sort of reception which awaits them at the hands of their chemical brethren in this country, should they be so unfortunate as to make any notable advance in chemical methods—especially in methods admitting of immediate

and practical application to such chemical questions as engage the attention of Government.

The ammonia process was published by me at the meeting of the Chemical Society held on the 20th of June, 1867; on which day I also gave evidence about it in the House of Lords, before the Royal Commission on Water Supply, and received a promise that our new method should be employed in the investigations undertaken for the Commission. The pledge was kept; the Commission received and made use of analyses done by the new process. Some of these analyses were made by my colleagues and myself at our own expense, but the greater number of them by Dr. Frankland and Dr. Odling, at the expense of the nation.

Chemists now in the habit of working the ammonia process will be amused (should they chance to turn to the blue-book containing the evidence of Drs. Frankland and Odling) to learn that these gentlemen did not get concordant results, which they attributed to some defect in the process. In 1868, many other chemists, high in official position, gave evidence before the Commissioners, and, being interrogated touching the working of our process, agreed mainly in this—That it was not a quantitative method. An honourable exception which I ought not to pass over was formed by Mr. Way, who, being in the year 1867, chemist on the Rivers' Commission, gave us his support at that early period in the history of our troubles. The last reports prepared by Mr. Way at that time contained very many water analyses done by the new process.

Very curious was the opposition we encountered at this stage of our career. One chemist could, as he informed the Chemical Section of the British Association in 1867, decompose a very dilute solution of albumen so completely, by boiling it with weak solution of carbonate of soda, as to obtain the whole of its nitrogen in the form of ammonia. Another chemist made some combustions of water residues (using a complicated apparatus for the purpose, but, as his test-analyses showed, not attaining any very unusual degree of accuracy), and wanted the Chemical Society to believe, because his combustions and our process assigned different characters to the same water, that, therefore, our process was fallacious—with combustions, confessedly tenths of a milligramme, and even a whole milligramme off the truth, he would correct, and control results claiming to be within one or two hundredths of a milligramme of the truth! One of our brethren could not work the Nessler test; another could not comprehend how we could divide organic substances so minutely as we claimed to do; another did not see how we could measure albumen quantitatively by the ammonia yielded by it, if only a definite fraction and not the entire nitrogen of the albumen were evolved as ammonia; and to this day some of our brethren have probably not been made to understand that in our first paper we described two distinct modifications of the ammonia process. But the ammonia process maintained its ground, and it is doubtful whether any new chemical method was so often and so widely practised within so short a period of its birth. I have related how from the very first the ammonia process was taken up by the two Government commissions which were sitting at the time of its invention. By-and-bye, it was adopted by the chemist to the Privy Council, the late Dr. Miller, whose latest water analyses for the Privy Council were done by our process. Almost as soon as intelligence of the method could reach the sanitary officers of our Indian Government they adopted it too. Even the Sewage Committee of the British Association used it.

J. Alfred Wanklyn.

ELECTRICAL POWER.

To the Editor of the Chemical News.

Sir,—In the thunderstorm which about a week ago utterly shattered a tree in these gardens, there is a remarkable illustration of the small *quantity* of electricity contained in a flash of lightning. The greater part of the electricity passed through an iron chair which stood under the tree. It had been newly painted green. The electricity on entering the iron reduced the metals in the paint (copper and lead) to a metallic state, at the same time fusing them. The nature of the action can scarcely be discerned by the naked eye, and probably there is not altogether half a grain of the reduced metal in the little metallic globules, which are visible by a microscope, deposited on the surface.

As the equivalent of lead is more than three times that of zinc, this is an illustration of Faraday's statement that a grain of zinc will produce more electricity in quantity than there is in a flash of lightning.—I am, &c.,

H. Highton.

2, The Cedars, Putney,
June 29, 1871.

MISCELLANEOUS.

Government Prosecution of a Chemical Works.—Mr. A. E. Fletcher, Government inspector of chemical works, has entered a suit against a St. Helen's firm for an infringement of the "Alkali Act," by allowing the escape of too much muriatic acid. As the firm immediately paid the prescribed fine of £50 the case will not be proceeded with. This is the fourth prosecution instituted since the passing of the act, and they have all been directed against the proprietors of works situated in St. Helen's and Widnes.—*Liverpool Mercury.*

Patent Law Reform.—At a meeting of London Patent Agents, held on the fourth instant, to consider the proposed changes in the patent laws, George Haseltine, M.A., in the chair, the following resolutions were adopted:—(1). That the chief defects of the patent laws have arisen from a want of appreciation of the *natural* rights of inventors to the sole use of their inventions, an unreserved recognition of which rights must pervade every equitable patent system, and the true aim of patent legislation is to harmonise these individual rights with the material interests of the state. (2). That the grant of patents to mere "*first importers*" is an injustice to inventors, an injury to society, as it induces the "pirating" of inventions, and the reason for these grants no longer existing, legislation should confine the issue of patents to actual inventors and their representatives. (3). That, in view of the benefits inventors confer on the public, and the expenses incident to the completion and introduction of new inventions, a patent for fourteen years is an inadequate compensation, and we deem it expedient to grant patents for a term of twenty-one years without the privilege of extension. (4). That the patent laws impose *penalties* upon inventors in the form of excessive fees, which justice and public policy demand should be reduced to the amount requisite to defray the expenses of an efficient administration of a simple patent system, and fees of ten pounds for the entire term—now one hundred and seventy-five pounds—would yield more than sufficient for the purpose. (5). That the defects of the present practice should be remedied by the adoption of equitable "regulations," and the introduction of the system of granting patents, at the risk of the applicants, without any official supervision of the specification or preliminary investigation of the merits of the invention. (6). That the rights of patentees should be determined by a competent tribunal, excluding all technical objections to the validity of the patent, and we deem it expedient to dispense with jurors and "scientific experts" in patent suits. (7). That these resolutions, signed by the Chairman, be forwarded to the Parliamentary "Select Committee on Letters Patent," and such other publicity be given them as he may deem conducive to the success of a liberal measure of patent legislation.

THE

MANUFACTURE OF CHLORINE.

THE process for the Manufacture of Chlorine which bears my name is now in operation at the works of the following manufacturers, who are now making by it a very large proportion of the total chlorine produced in this country:—

Messrs. C. ALLHUSEN & SONS, Newcastle-on-Tyne.
„ BLACK & CO., South Shields.
„ J. C. GAMBLE & SONS, St. Helens.
„ GASKELL, DEACON, & CO., Widnes.
„ HALL BROTHERS & SHAW, Widnes.
The HARDSHAW BROOK CHEMICAL COMPANY, St. Helens.
Mr. WILLIAM HUNT, Castleford.
Mr. A. G. KURTZ, St. Helens.
Messrs. W. J. KANE & SON, Dublin.
„ JAMES MUSPRATT & SONS, Widnes.
Mr. MORGAN MOONEY, Dublin.
Messrs. H. L. PATTINSON & CO., Newcastle-on-Tyne.
„ W. PILKINGTON & SONS, Widnes.
„ SULLIVAN & CO., Widnes.
The WALKER ALKALI COMPANY, Newcastle-on-Tyne.

The following, though not yet actually working the process, have very nearly completed apparatus for it:—

Messrs. CHARLES TENNANT & CO., Glasgow.
„ MUSPRATT BROTHERS & HUNTLEY, Flint.
The RUNCORN SOAP & ALKALI COMPANY, Weston.
The NETHAM CHEMICAL COMPANY, Bristol.

The cost of the regeneration by my process of manganese enough for the production of a ton of bleaching-powder does not average more than about fifteen shillings; and in comparing the cost of my process with that of the old process, only a part of even this fifteen shillings has to be counted, seeing that the solution of my mud requires so much less labour and fuel than are required for the solution of native manganese. The only labour involved in the working of Weldon stills consists in opening and shutting a few cocks. One still can produce chlorine enough for from 15 to 30 tons of bleaching-powder per week, and one workman can attend to as many stills as are required for the production of the largest quantity of chlorine made by any one firm in the world.

The consumption of acid, in my process, per ton of bleaching-powder, is shown by the following figures, for which I am indebted to the courtesy of a Widnes firm. They are for the ten weeks from April 4th to June 20th, 1871, omitting Whitsun week:—

April 4th to May 30th.

Average bleaching-powder made per week ..	44 tons 1 cwt.
Average strength of the bleaching-powder (chamber-test)	37·34 per cent.
Acid at 24° T. used per ton	172 cubic feet.

Week ending June 13th.

Bleaching-powder made	43 tons 11 cwts. 2 qrs.
Average chamber-test of ditto	37·23 per cent.
Acid at 24° T. per ton	166 cubic feet.

Week ending June 20th.

Bleaching-powder made..	43 tons 5 cwts. 1 qr.
Average chamber-test of ditto	36·18 per cent.
Acid at 24° T. per ton	140 cubic feet.

The average consumption of acid, by the firm in question, for the ten weeks, was thus 166 cubic feet at 24° T., per ton of bleaching-powder.

The firm who have given me the above figures use Buxton lime. When an inferior kind of lime is used the consumption of acid is greater, but I believe that the average consumption, per ton of bleaching powder, by all the firms employing my process, does not exceed 170 cubic feet at 24° Twaddell, or the quantity containing 2832 lbs. real HCl.

Although, at present, for every 2832 lbs. HCl going into their stills, few British manufacturers decompose less than 60, while many decompose 80, or even more than 80, cwts. of salt, that quantity of acid *might* go into the stills for every 47 or 47½ cwts. of salt decomposed. In a paper presented to the Chemical Section of the British Association in 1863, by Lieut.-Colonel Allhusen and Mr. R. Calvert Clapham, it was shewn that the quantity of HCl actually condensed at the works of Messrs. Allhusen and those of the Walker Alkali Company was 55·8 parts per 100 parts of salt decomposed: which would give 2832 lbs. HCl per 45 cwts. and 37 lbs. of salt. There can be little doubt that that quantity of acid is nearly always condensed per 46 cwts. of salt decomposed; and I hold that, within 2 or 3 per cent, *all* the acid condensed *might* go into the stills. There are manufacturers working on the Lancashire system nearly a third of whose acid goes down their wash-towers; but there are others who do not send down their wash-towers, per ton of salt decomposed, more than the equivalent of 1¼ cubic feet of acid at 24° T., and what is done by these latter is of course possible for all who use close roasters. Nor need those who use open roasters have less acid for their stills, per quantity of salt decomposed, than manufacturers working on the other plan, seeing that the acid from open roasters can easily be got strong enough for a mixture of it with the pot-acid to be of quite sufficient strength for the solution of my mud.

It is perfectly possible, then, for 2832 lbs. HCl to be got into the chlorine-stills for every 47½ cwts. of salt decomposed. But this quantity of acid is more than *need* be used per ton of bleaching-powder made by my process, as at present practised. It includes about 500 lbs. going out of the stills as free acid, and afterwards neutralized by limestone. A slight increase of still-power, permitting the stills to be worked with an excess of mud, would enable these 500 lbs. of lost acid to be reduced to 200 lbs. This would reduce the 2832 lbs. HCl to 2532 lbs., and so enable any manufacturer obtaining, in a state in which it could go into his stills, that proportion of his acid which might easily be obtained in that state by proper arrangements, to make, by the form of my process at present in use, a ton of bleaching-powder, at 37 per cent, for every 42 cwts. of salt which he decomposed.

But there is another form of my process, which is capable of yielding a ton of bleaching-powder from as little as *fourteen hundredweights* of salt. In this form of the process the chloride of manganese is decomposed by magnesia, instead of by lime, and the resulting chloride of magnesium is then decomposed by heat into magnesia and hydrochloric acid. The same magnesia serves over and over again continually; the loss of manganese which is inseparable from the lime form of the process is avoided; nothing is consumed but coal and air; and all the chlorine contained in the acid employed is yielded, if desired, in the free state. Bleaching-powder was successfully made by this form of the process, at the works of Messrs. J. C. GAMBLE & SONS, as far back as 1868, and at the Works of the HARDSHAW BROOK CHEMICAL COMPANY improved apparatus for it is now being prepared, and will be in operation very shortly.

Several processes for the manufacture of chlorine in which manganese is not used, the chlorine being obtained by the decomposition either of hydrochloric acid or of metallic chlorides by means of atmospheric air directly applied, are now being experimented with. Theoretically, these processes also should yield as much chlorine as the magnesia form of the manganese process, but I believe that it will be found that the reactions on which they are based can be carried to *completeness* only by the use of such an excess of air as to render the chlorine obtained so dilute as to require impracticably large apparatus for its absorption, and hence that in practice they can be carried only so far as to make the actual yield of chlorine fall very much below that which I have every confidence that I shall soon be realizing at Hardshaw Brook; while the chlorine yielded by these processes, even when obtained by only partial decompositions, is so mixed with other gases that its absorption has as yet been effected only by causing it to travel, in apparatus of special construction, for a very long distance over exceedingly thin layers of lime. The magnesia form of my process, however, yields the chlorine in a state in which it can be employed in the ordinary chambers, and I believe that that form of my process will be found to possess so many other practical advantages as to maintain, unimpaired, the supremacy of manganese as the agent by whose means chlorine can be most conveniently and economically manufactured.

WALTER WELDON.

OFFICES OF WELDON'S CHLORINE PROCESSES COMPANY, (LIMITED),
59, LINCOLN'S INN FIELDS, LONDON, W.C.

June 29th, 1871.

THE CHEMICAL NEWS.

VOL. XXIV. No. 607.

ON PROTOPLASMIC LIFE.

By F. CRACE CALVERT, F.R.S., &c.

A YEAR since, the publication of Dr. Tyndall's interesting paper on the abundance of germ-life in the atmosphere, and the difficulty of destroying this life, as well as other papers published by eminent men of science, suggested the inquiry if the germs existing or produced in a liquid in a state of fermentation or of putrefaction could be conveyed to a liquid susceptible of entering into these states; and although at the present time the results of this inquiry are not sufficiently complete for publication, still I have observed some facts arising out of the subject of protoplasmic life which I wish now to lay before the Royal Society.

Although prepared, by the perusal of the papers of many workers in this field, to experience difficulties in prosecuting the study, I must confess I did not calculate on encountering so many as I met, and especially those arising from the rapid development of germ-life, and of which I have hitherto seen no notice in any papers which have come under my observation. Thus, if the white of a new-laid egg be mixed with water (free from life), and exposed to the atmosphere for only fifteen minutes, in the months of August or September, it will show life in abundance. From this cause I was misled in many of my earlier experiments, not having been sufficiently careful to avoid even momentary exposure of the fluids to the atmosphere. To the want of the knowledge of this fact may be traced the erroneous conclusions arrived at by several gentlemen who had devoted their attention to the subject of spontaneous generation.

I believe that I have overcome the difficulty of the fluids under examination becoming polluted by impregnation by the protoplasmic life existing in the atmosphere, by adopting the following simple method of working.

As a pure fluid free from life, and having no chemical reaction, was essential to carrying out the investigation, I directed my attention to the preparation of pure distilled water. Having always found life in distilled water prepared by the ordinary methods, by keeping it a few days, after many trials I employed the following apparatus, which gave very satisfactory results, as it enabled me to obtain water which remained free from life for several months.

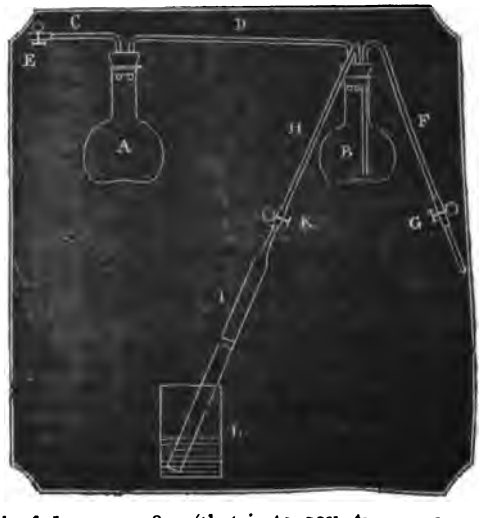
It consists of two flasks, A and B (A rather larger than B), fitted with perforated caoutchouc stoppers.* These flasks are connected by the tube D. Into the stopper of A is fitted a tube C, to which is joined a piece of caoutchouc tubing, which may be closed by the clip E. Through the stopper of B is a syphon, F, the long limb of which is cut and joined with caoutchouc tubing, which can be closed by the clip G. Through this stopper is a third tube, H, connected by caoutchouc with the tube I; this can be closed by the clip K. The tube, I, is about 3 feet long, and goes into the vessel L, which is partly filled with water.

The water to be distilled is mixed with solution of potash and permanganate of potash, and placed in the flask A.† Before distillation is commenced, a rapid current of pure hydrogen or some other gas must be passed through the apparatus by the tube C to displace the air and carry off all the germs the air may have contained. The clip G is first left open, then this closed and the clip K opened, which allows the gas to pass through the water in the vessel L.

The gas should be passed through for about fifteen minutes. The clip E is then closed, and the distillation carried on. When the operation is complete, the gas must be again passed through the apparatus, and the connection with the tube I broken by closing the clip K. The water is drawn off through the syphon F. The long tube acts as a safety-tube, and is made so long that the absorption is noticed in ample time to close the clip before any air can enter through that tube.

The water has to be re-distilled three or four times before it is obtained free from germs, and must be kept in the apparatus in which it is distilled until wanted, to prevent any contact with air.

Some water which had been distilled on the 20th of November, 1870, being still free from life on the 7th of December, was introduced by the syphon H into twelve small tubes, and left exposed to the atmosphere for fifteen hours, when the tubes were closed. Every eight days some of the tubes were opened, and their contents examined. On the fifteenth, therefore, the first examination was made, when no life was observed; on the twenty-third two or three other tubes were examined, and again no life was detected; whilst in the series opened on the



2nd of January, 1871 (that is to say, twenty-four days from the time the tubes were closed), two or three black vibrios were found in each field.

Being impressed with the idea that this slow and limited development of protoplasmic life might be attributed to the small amount of life existing in the atmosphere at this period of the year,* a second series of experiments was commenced on the 4th of January. The distilled water in the flask being still free from life, a certain quantity of it was put into twelve small tubes, which were placed near putrid meat at a temperature of 21° to 26° C. for two hours, and then sealed. On the 10th of the same month the contents of some of the tubes were examined, when two or three small black vibrios were observed under each field. This result shows that the fluid having been placed near a source of protoplasmic life, germs had introduced themselves in two hours in sufficient quantity for life to become visible in six days instead of twenty-four. Other tubes of

* The stoppers and caoutchouc tubing used for the various joints must be new, and must be well boiled in water before use.

† The reasons why I employed permanganate of potash (in large excess) were that, under the influence of heat, its oxidising powers were much increased, and that it gave off no gas that could interfere with the purity of the water, this salt in solution not even yielding oxygen under any circumstances.

* During the intense cold of December and January last I found it took an exposure to the atmosphere of two days at a temperature of 12° C. before life appeared in solution of white of egg in the pure distilled water, whilst as the weather got warmer the time required became less.

this series were opened on the 17th of January, when a slight increase of life was noticed; but no further development appeared to take place after this date, as some examined on the 10th of March did not contain more life than those of the 17th of January.

This very limited amount of life suggested the idea that it might be due to the employment of perfectly pure water, and that the vibrios did not increase from want of the elements necessary for sustaining their life. I therefore commenced a third series of experiments. Before proceeding to describe this series, I would call attention to the fact that the water in the flask had remained perfectly free from life up to this time, a period of close on sixteen weeks.

On the 9th of February 100 fluid grains of albumen from a new-laid egg were introduced, as quickly as possible and with the greatest care, into 10 ounces of pure distilled water contained in the flask in which it had been condensed, and an atmosphere of hydrogen kept over it. On the 16th some of the fluid was taken out by means of the syphon H, and examined, and no life being present, twelve tubes were filled with the fluid, exposed to the air for eight hours, and closed. On the 21st the contents of some of the tubes were examined, when a few vibrios and microzyma were distinctly seen in each field. On the 27th other tubes were examined, and showed a marked increase in the amount of life. In this series life appeared in five days, and an increase in ten, instead of requiring twenty-four days, as was the case when pure water only was employed.

Albumen therefore facilitated the development of life. Of course the contents of the flask were examined at the same time, but in no instance was life detected. I believe that these three series of experiments tend to prove the fallacy of the theory of spontaneous generation; for if it were possible, why should not life have appeared in the pure distilled water, or in the albuminous solution, which were kept successively in the flask B, as well as in the fluids which were contained in the tubes, and had been exposed to the atmosphere or near animal matter in a state of decay, and had thus become impregnated with the germs of protoplasmic life? What gives still further interest to these experiments is, that, having operated during the severe weather of last winter, when little or no life existed in the atmosphere, I was able to impregnate the fluids with germs without introducing developed life.

The quantity of life produced in the above-recited experiments being comparatively small, I was led to infer that this might be due to the influence of the atmosphere of hydrogen employed to displace the air in the apparatus used for obtaining the water. I, therefore, on the 2nd of March, prepared a solution of albumen similar to that before employed, but expelled the air out of the apparatus by pure oxygen; and as the contents of the flask B were free from life on the 8th of March, a series of small tubes were filled and exposed for twenty-six hours to the atmosphere near putrid matter, and then sealed. Several of these tubes were opened on the 11th, and immediately examined, when only a few cells were observed in each field. A second lot was opened on the 14th, and they showed considerable increase of life, there being two or three vibrios under each field. A third quantity was opened on the 25th, when no increase had taken place. This latter result tends to show that although oxygen appears to favour the development of germs, still it does not appear to favour their reproduction.

As the weather had become much warmer, and a marked increase of life in the atmosphere had taken place, some of the same albumen solution as had been employed in the above experiments was left exposed in similar tubes to its influence, when a large quantity of life was rapidly developed and continued to increase. This result appears to show that the increase of life is not due to reproduction merely, but to the introduction of fresh germs; for, excepting this fresh supply, there appears to be no reason why life should increase more rapidly in the open than in the closed tubes.

In concluding this paper I have great pleasure in recognising the able and persevering attention with which my assistant, Mr. William Thompson, has carried out these experiments.

ASSAY OF GOLD AND SILVER,

AS PRACTISED AT THE LABORATORY OF THE SCHOOL OF MINES, COLUMBIA COLLEGE.

By T. M. BLOSSOM, E.M.

All substances containing gold and silver may, for the purpose of the assayer, be divided into two classes, as follows:—

Class I.—Minerals or ores, including incidental industrial products.

Class II.—Metallic gold and silver, and alloys, native or artificial.

Gold.

Class I.—Minerals.

Sylvanite—Graphic Tellurium....$(AuAg)Te_3$—Au 30—Ag 10.
Nagyagite—Foliated Tellurium..$(Pb,Au,Ag)_{21}(Te,Sb,S)_3$—Au9—Ago·5

Class II.—Alloys.

Native Gold		AuAg—Au65—99.
Palladium Gold	Porpezite	$AuPd$—$Au_{85·98}Ag_{4·17}$.
Rhodium Gold		AuRd—Au59—66.
Gold Amalgam		$(AuAg)_4Hg_5$—$Au_{38·39}Ag_5$.
Artificial Alloys	Gold Coin, Jewelry, &c.	

Of the foregoing list, native gold alone occurs in nature in sufficient abundance to acquire any great commercial value. It is commonly found in a quartzose gangue, and nearly always associated with one, or more, of the following minerals: Iron and copper pyrites, mispickel or arsenical pyrites, blende, and galena.

Silver.

Class I.—Ores and Minerals.

Mineral.	Formula.	Per cent of Silver.
1. Naumannite	$AgSe$	73·20
2. Eucairite	$CuSe+AgSe$	43·10
3. Hessite	$AgTe$	62·80
4. Sylvanite	$(AuAg)Te_3$	10·00—15·00
5. Silver Glance	AgS	87·04
6. Stromeyerite	$(Ag,2Cu)S$	2·96—53·10
7. Sternbergite	$AgS+3FeS+FeS_2$	34·20
8. Miargyrite	AgS,Sb_2S_3	36·70
9. Pyrargyrite	$3AgS,Sb_2S_3$	59·80
10. Proustite	$3AgS,As_2S_3$	65·40
11. Stephanite	$5AgS,Sb_2S_3$	68·50
12. Brogniardite	PbS,AgS,Sb_2S_3	26·10
13. Polybasite	$9(Ag,2Cu)S,(Sb,As)_2S_3$	68·00
14. Tetrahedrite	$4(2Cu,Fe,Zn,Ag,Hg)S,(Sb,As,Bi)_2S_3$	3·09—31·29
15. Xanthoconite	$(3AgS,As_2S_3)+2(3AgS,As_2S_3)$	64·00
16. Fireblende	$Ag—Sb—S$	62·30
17. Freieslebenite	$5(Pb,Ag)S,2Sb_2S_3$	22—24
18. Kerargyrite	$AgCl$	75·33
19. Bromyrite	$AgBr$	57·40
20. Embolite	$Ag(Cl,Br)$	61·71
21. Iodorite	AgI	46·00

Minerals often containing silver in small quantities:—

1. Galena .. PbS.
2. Blende .. ZnS.
3. Pyrites .. FeS_2.
4. Chalcopyrite .. Cu_2S,Fe_2S_3.
5. Erubescite .. $3Cu_2S,Fe_2S_3$.
6. Mispickel .. FeS_2+FeAs_2.
7. Altaite .. $PbTe$.
8. Nagyagite .. $(Pb,Au,Ag)_2,(Te,Sb,S)_2$.
9. Chiviatite .. $(Cu_2Pb)S.\frac{2}{3}Bi_2S_3$.
10. Dufrenoysite .. $2PbS,As_2S_3$.
11. Enargite .. $3Cu_2S,As_2S_5$.
12. Slags, &c.
13. Cupel Bottoms, Dross, Litharge, &c.

Class II.—Alloys.

Alloy.	Formula.	Per cent.
1. Native Silver..	AgAu (generally),	..
2. Native Gold	AuAg	Ag1—35
3. Native Copper	Cu	sometimes 10
4. Chilenite	Ag_6Bi	Ag86·2
5. Bismuth Silver	Ag—Cu—As—Bi	Ag60·0
6. Discrasite { Antimonial Silver }	Ag_2Sb	Ag78·0
7. Amalgam	$AgHg_2$	Ag35·0
,, ...	$AgHg_3$	Ag26·0
8. Arquerite	Ag_6Hg	Ag86·5
9. Artificial Alloys ..	Silver Coin, Jewelry, &c.	

The principal sources of silver are, silver glance, stephanite, pyrargyrite, and kerargyrite, native silver, galena, and argentiferous copper ores.

The assay of gold and silver, therefore, comprises—

I. Assay of Ores, II. Assay of Alloys, according as we have presented to us material of Class I. or of Class II.

I. Assay of Ores.

Assays of gold and of silver ores are made in a manner almost precisely the same, so that a general description will answer for both, the peculiar requirements of each being pointed out in place. The assay of ores embraces the following steps:—

1. Preparation of the sample. 2. Collection of the gold and silver in a button of metallic lead. 3. Cupellation of the lead button, by which the lead is oxidised and absorbed by the cupel, leaving behind a bead of the gold and silver. 4. Weighing the bead. 5. Inquartation, parting, and cupellation of the gold residue. 6. Weighing the gold bead.

1. *Preparation of the Sample.*—It is essential, in the first place, to obtain a fair average sample of the ore, otherwise the results of the assay may be commercially worthless. Selection must be left to the judgment of the assayer. The sample must be dried, if necessary, care being taken not to roast it. It must then be pounded in an iron mortar and passed through a sieve of eighty meshes to the linear inch. If any native metal, in the form of scales or filaments, remain upon the sieve, take the weights, separately, of what has passed through and of what is left upon the sieve. The latter must be assayed according to "Assay of Alloys," and the result referred to the whole amount of ore. (See Calculation of Results.) It is essential that the whole of the sample except the malleable portion, be passed through the sieve. Mix thoroughly the sifted ore.

2. *The Collection of the Gold and Silver* in a button of metallic lead is effected in a crucible, or in a scorifier, whence two methods of assay:—

(*a.*) Crucible assay. (*b.*) Scorification assay.

The former is applicable to all ores; the latter is limited, practically, by the small size of scorifiers to the richer ores.

(*a.*) Crucible assay.—An ore of gold and silver is composed of precious metal, gangue, and oxides, sulphides, &c., of foreign metals. To collect the precious metals in a button of lead, the ore is mixed with litharge, suitable fluxes, an oxidising or a reducing agent, and fused in the crucible. Litharge is reduced to metallic lead; the latter seizes upon the precious metals and collects in a button at the bottom of the crucible, while the foreign materials form, with the fluxes, a fusible slag above the lead button. The crucible is broken when cold, and the malleable button detached from the slag by hammering on an anvil.

The following are the necessary reagents for crucible assays:—

Reagents.

Litharge.—To supply lead; to oxidise sulphur, arsenic, antimony, &c., to flux siliceous material and impurities in general.

Carbonate of Soda or of Potash.—A substitute in part for litharge, to flux siliceous and other impurities. The alkaline carbonates have the power, also, of oxidising many metals, as iron, zinc, tin, by means of the carbonic acid they contain.

Nitre.—To oxidise sulphur, arsenic, &c.

Argol (crude bitartrate of potash).—To reduce litharge to metallic lead.

Charcoal.—A substitute for argol; also used in roasting ores, to decompose arseniates and antimoniates.

Borax Glass.—To flux oxidised basic impurities, such as alumina, lime, magnesia, and oxide of iron. Borax is neither oxidising nor desulphurising.

Silica, or Powdered Glass.—Used sometimes as a substitute for borax.

Common Salt.—To cover the charge in the crucible. It also serves to wash down the sides of the crucible, if the charge boil up.

Carbonate of Ammonia.—Used in roasting ores, to decompose sulphates.

The reagents must all be finely pulverised and dried, and kept in closed vessels.

Carbonate of soda is better than carbonate of potash, because it does not deliquesce. Borax should be fused to a glass and pulverised. This prevents the loss which its boiling up might occasion, if used in the ordinary state. Litharge is an almost universal flux, and might be employed alone; but, as in this case a large amount would be required, there would be danger of losing the charge, through piercing of the crucible. Carbonate of soda is, therefore, substituted for a part of the litharge. There is an extra advantage in the use of carbonate of soda, arising from the fact that alkaline carbonates, on account of their great fusibility, can hold in suspension, without losing their fluidity, a large proportion of pulverised infusible substances.

Preliminary Assays of Reagents.

Ordinary commercial litharge always contains silver, so it becomes necessary to determine in each new lot the amount of silver contained, for deduction from the silver found in the regular assay of an ore. We must also determine, beforehand, the reducing powers of argol and charcoal, and the oxidising power of nitre. This necessity arises from the impurities of the reagents. By reducing power, we mean the amount of metallic lead that one gramme of the reagent will reduce from litharge, and by oxidising power the amount of metallic lead that one gramme of nitre will oxidise. The following are the charges for the preliminary assays:—

1.—*Reducing Power.*

Argol.		Charcoal.	
Argol	2 grms.	Charcoal	1 grm.
Litharge	2 A. T.*	Litharge	2 A. T.
Carb. Soda ..	½ A. T.	Carb. Soda.. ..	½ A. T.
Salt	Cover.	Salt	Cover.

2.—*Oxidising Power.*

Nitre	3 grms.
Charcoal	1 grm.
Litharge	2 A. T.
Carb. Soda ..	½ A. T.
Salt	Cover.

3.—Ag. *in Litharge.*

Litharge	4 A. T
Carb. Soda.. ..	2 A. T.
Charcoal	1 grm.
Salt	Cover.

In these, as in all other cases, except when the contrary is specified, duplicate charges must be made, to afford

* Prof. Chandler has devised and adopted, in addition to the French system, a set of weights similar to that employed by the German assayers. This set includes weights designated "Assay Tons," and fractions thereof, as follows: 4 A. T., 2 A. T., 1 A. T., ½ A. T., 1-6 A. T., 1-10 A. T. The assay ton weighs 29·1666 grms., and bears the same relation to a milligramme as the ton of 2000 lbs. av. bears to the troy ounce, *i.e.*,

$$1 \text{ milligramme} = \frac{1 \text{ (A. T.)}}{29{,}166} \text{ and } 1 \text{ oz. troy} = \frac{2000 \text{ (lbs. av.)}}{29{,}166}$$

A milligramme, then, is the assay ounce. The advantage of these weights is apparent. The ore for an assay is weighed in assay tons. Suppose that we obtain from 1 A. T. of ore 85 milligrammes, or assay ounces, of silver, we know, without calculation, that a ton of 2000 lbs. avoirdupois will yield 85 ounces troy. An article on this "New System of Assay Weights" may be found in the American supplement of the *Chemical News* for August, 1869.

some check upon the results obtained. If they differ greatly, another assay must be made; if only slightly, the mean may be taken. In the case of (1) and (2) the same precautions are necessary as in the preliminary assay of an ore. (See farther on).

All the charges require a hot fire, should be withdrawn from the furnace as soon as completely fused, and the crucibles should be tapped gently while held in the tongs, to detach any particles of lead adhering to the sides. When cold they are broken and the lead buttons are hammered into a cubical form, both because this is a convenient shape and because the buttons are thus freed from all slag. Weigh the buttons of (1) and (2) and note, in each case, the mean weight. The buttons of (1) tell us how much lead is reduced by 2 grammes of argol and by 1 gramme of charcoal. The reducing power follows. In the case of (2) we should, in the absence of nitre, have obtained a button of a certain weight, say 28 grammes, due to the charcoal present. We have obtained a button of less weight, say 13 grammes, that is, 3 grammes nitre have oxidised part of the lead, 15 grammes, whence 1 gramme nitre will oxidise 5 grammes lead. The lead button from (3) on being cupelled, will yield a bead of silver representing the amount in 4 assay tons of litharge.

In the regular assay, nitre does not act by oxidising metallic lead, but it attacks its equivalent reducing agent in the ore, be it sulphur, arsenic, or other constituent.

(To be continued).

ON THE ORIGIN OF THE DIAMOND.*

By the Rev. W. B. CLARKE, M.A., F.G.S.

CONNECTED with coal plants in transmuted deposits there has arisen another enquiry amongst ourselves as to the probable origin of the diamond. How has the diamond been produced, and to what geological formation does it belong, are questions which have had various replies. Although we may not be able to solve the mystery, it may, perchance, be not uninteresting to review the statements that have been put forth by different authorities, now the public mind in Australia is excited by accounts of increasing discoveries of the precious gem in New South Wales.

It appears that I did not miscalculate when, in 1860, I headed a notice of five diamonds that had come into my hands, "New South Wales a Diamond Country ("Southern Gold Fields," p. 272); for, up to the present time, several thousands have been brought to light. In some valuable papers by Mr. Norman Taylor, and in a report of similar character by Professor Thomson of our University, may be found a clear exposition of the phenomena presented in the diamond field at Two-mile Flat on the Cudgegong River, which these gentlemen have recently explored and described.

The opinions expressed by them are to the effect that the diamond district is limited to the presence of an ancient drift deposit covered generally by basaltic rocks, and that when found in the river bed, or in alluvial soil, the diamonds are frequently scratched and broken, whilst in the drift alluded to they are found intact. And at the points where they are thus found in the river bed, they are so found in consequence of the tailings of the miners having been washed thereto.

The river having changed its course, the area referred to is merely an alluvial space at one of those points.

The general formations of more ancient date in the vicinity are considered to be Upper Silurian traversed by greenstone, with overlying carboniferous beds as outliers of more extended strata. Mr. Norman Taylor has suggested that the diamonds have been in some way derived from the carbon in the coal measures. Opinions as to the derivation of diamond from vegetable matter by a process of distillation, somewhat like that to which coal is due, and even from animal matter capable of supplying carbon, have been long held by certain philosophers.

Considering the facts glanced at before,* relating to the transmutation of rocks by heat and other agencies, the formation of diamond in the humid way does not appear to me an extravagant supposition. But, on examining the sand or deposit in which the Cudgegong Diamonds are found, I was struck with the amount of minute gems, such as zircon, topaz, sapphire, corundum, spinel, pleonaste, &c., which composed the finest sifted material in which gold is also found; and Mr. Norman Taylor dwells on the circumstance, that the diamond is not only associated with the gold (as in most other foreign localities), but with those gems which are held to have had an igneous origin, occurring as they do in rocks which are so denominated; and in some cases (I may add) in true lava of modern volcanos.

But before I go further into this question, I must digress, in order to explain, that though diamond is thus associated, on the Cudgegong and on the Macquarie, as at Suttor's Bar, yet there are in my knowledge hundreds of spots throughout the length and breadth of Australia where the same gems are found in as great abundance, often of much larger proportions, with or without gold and without a trace of the existence of diamond. I have found them myself in this way in a variety of places in this and the neighbouring colonies, in an area which I do not exaggerate when I call it a hundred thousand square miles; and within the last year I have received thousands of such gems from correspondents and visitors who have consulted me, without finding among them more than a few diamonds and but ten independent of the present produce from Two Mile Flat and Suttor's Bar.

Those ten were found not far from Bingera, and are the first fruits of a new locality. They were accompanied by zircon, larger than any found with diamonds on the Cudgegong, but also with very small crystallisations of the same mineral and quartz. The friend to whom I am indebted for the examination of these diamonds is encouraging a search for more. I may add that I have seen no diamond from Cudgegong exactly resembling those from Bingera.

I have received also two diamonds said to be found near Kangaloon, on the Mittagong Range; but, as many other minerals which are probably not indigenous there, have also been forwarded from the same neighbourhood, I have much hesitation in accepting the statements made.

A further announcement was made to me in 1870, of diamonds on the Darling, a few miles from Fort Bourke, but on examining a large collection of the pebbles consigned to the Commercial Banking Company as "diamonds" and "precious stones," I found that they were all varieties of silica [quartz, jasper, agate, chalcedony], with small highly polished fragments of fossil wood and other drift.

On the Cudgegong there are five principal places where the mineral is found. They occur at various depths from the surface, greenstone in some instances having caused the formation of unequal hollows for the collection of drift. The intrusive rock follows the strike of the older rocks, which is about N. 25° W.

The older drift has been since covered by a basaltic flow, which in turn has suffered from the denudation that has spread the drift, so producing a younger drift, to which Mr. Norman Taylor assigns the term Newer Pliocene, in contrast with the older. This designation is, no doubt, due to his Victorian practice. The basalt he compares with that of the Coliban River in Victoria, which from my own personal knowledge of that locality I can confirm.

The carboniferous rocks have not furnished much detritus to the older drifts; but such occurs abundantly

* From the Anniversary Address delivered to the Royal Society of New South Wales.

* "On the Transmutation of Rocks in Australasia," by the Rev. W. B. Clarke, M.A.; read before the Philosophical Society of N.S.W., May 10, 1865 (T. P. S., p. 266).

in the river bed. A still more recent wash of drift occurs on the present surface.

Mr. Taylor very properly presents to notice a difficulty which has been hinted at already.

If the diamonds were derived from the carboniferous rocks, why are they not found in the river bed, except where the tailings of the miners have been washed in? From all the evidence arrived at, the newer drift is derived from the older, and with them is associated a cement of quartz and altered rock held by a yellowish green silicate of iron and hydroxide of iron, from hand specimens of which I have myself taken gold. Mr. Taylor says it contains diamonds also.

Many of the pebbles, which are of quartz and very hard flinty altered rock, have long attracted my attention, on account of the glaze or polish which they wear. They have exactly the outward coating which distinguishes so many of the surface pebbles found in the very heart of the interior of Australia, traversed by Sturt, M'Kinlay, and Burke and Wills. What may have been the way in which these pebbles have been polished is not easy to be discovered. Iron sand, or, better still, perhaps, gem sand, in violent motion, may have been the agent, since we know granite rocks in sandy desserts are polished by sand-flows far from water. It has been suggested, that the polish arises from the action of silicated water, as the hollows in the pebbles are as smooth as the general surface. But they are only in the condition of the greatest part of the surface drift all over the interior of New Holland. Unless, therefore, we assume, that a flood of silicated water has covered the greater part of New Holland, we cannot so explain the phenomenon. If, on the other hand, the gems and the iron belong to the basaltic rocks, and if these are younger than the cement, such an explanation can only be accepted in connection with a much more distant origin for the pebbles than any local strata. The older drift, therefore, cannot have a local origin.

It is certain, moreover, that if the other gems have been derived from basaltic rocks, and not from the greenstone, of which there is no evidence, the basalt was of an older period than that which now covers the drift, and such older basalt is not traceable. All, therefore, favours the belief that the term drift, implying a driving of material from a distance, is a correct term to apply to the diamond-bearing deposits; but a question of another kind immediately suggests itself,—Was the motive power of this drift, and of necessity of the gold drifts, *fluviatile* or *glacial?* A marine accumulation is not suggested; and no fossil remains, favouring such a solution of the question, have been found. Silicified wood of the carboniferous age occurs abundantly in the drift; but it must have been silicified long before any diamond could have been formed from the carbon which the original wood contained, unless diamonds claim an antiquity as high as that of the coal measures themselves, or even one higher than theirs. In that case, they must also be drifted, as well as the minerals and rocks that are associated with them.

This may be the final result of our enquiries, but there are many who (as Mr. Taylor does) think the diamond is a product of chemical forces now in operation, and therefore, it is a strictly local and limited product, not necessarily connected with any carboniferous beds of comparatively high antiquity, As magnesite exists in the vicinity, and that is certainly a recent product, arising from the decomposition of the exposed igneous rocks, so infiltration, decomposition, and reconstruction of carbonaceous materials, of whatever age, under the influence of chemical transformation, may be producing diamonds at this moment, wherever the needful conditions exist.

An author of some distinction, M. Favre, Professor of Geology at Geneva, has turned his attention to this very subject, and as his paper "On Artificial Minerals" may not be generally known, I will refer to it. [It is to be found in the *Bulletin* of the *Société Geologique de France*, vol. xii., 2nd series.] He therein reviews the experiments which, up to 1855, had been made in the production of artificial diamonds, and refers to the experiments of M. Jaquelain who had procured from the diamond a carbonaceous matter having the aspect of coke, and those of M. Despretz who had proved that melted carbon and melted diamond are nothing but graphite. This is akin to the idea of Glocker of Breslau, and of others before him, that diamond is an altered coal. Petzholdt also found in different diamonds—especially the brown—traces of similar organisation to that of silicified vegetable matter; but Dufrenoy rejects the opinion of Liebig, that they can have a vegetable origin.

M. Favre shows, that of thirty-four minerals found with diamond (according to the catalogue of M. Denis), consisting of sulphurets, carbonates, oxides, silicates, and native metals, thirty have been artificially produced; and of the thirty, twenty-nine were produced by the aid of volatile chlorides.

If this be the case, though one of the conditions is heat, the argument as to an igneous origin for diamond, because it is found in association with minerals of igneous origin, must be abandoned or modified.

Ten years later, Professor Goppert, in his work "On the Organic Nature of the Diamond," pointed out, as Jaquelain had done, that it may be turned into coke. He says, that some must have been soft, as they are superficially impressed by sand and crystals; that others contain crystals of other minerals, germs of plants, and fragments of vegetation. Hence, it would certainly appear, that the origin of such diamonds cannot have been igneous, and, I may add, assuredly not more so than those granitic rocks I have already mentioned, that contain coal measure plants. He states further, in 1868, that he had a diamond which contained *dendrites*, such as occurs on minerals of aqueous origin; that there are at Berlin, one which contains bodies resembling *Protococcus pluvialis*, and another green corpuscles linked together, closely resembling *Palmoglæa macrococca*. To these supposed Algæ the names have been given of *P. adamantinus* and *Palmogleites adamantinus*. As illustrating the views he takes of these diamonds he says, the metamorphic rocks in which they occur also contain evidences of vegetable fossils, such as *Eozoon canadense*; and that even in some topazes there are traces of organic substances.

A very interesting lecture was delivered by Dr. Percy, "On Chemical Geology," on December 12, 1863, before the School of Mines, in which he treats of the formation of silica; of "that glorous mineral corundum;" of spinel, and of other gem stones; showing the influence of water, moderate heat, and salts of chromium, and he then adds: "the diamond will come ultimately, no doubt." There is nothing to show that an igneous origin is attributed to them.

As an item in this enquiry, we may refer to a notice in *Silliman's American Journal* (vol. vi., p. 110), 1848, by Professors E. and W. B. Rogers, referring to a previous paper, on "A New Method of Determining the Carbon in Graphite" (vol. v., p. 392), in which the authors show that "the diamond may be converted into carbonic acid in the liquid way, and at a moderate heat, by the reaction of a mixture of bi-chromate of potassa and sulphuric acid, in other words, by the oxidating power of chromic acid." The method is much the same, as in the process of oxidating graphite. By this method, they obtained from half a grain of diamond an evolution of as much carbon as was nearly equal to what was due to the entire weight of the diamond.

On the other hand, Sir J. Herschel (Physical Geography) quotes the case of a Bahia diamond mentioned by Harting, which contained well-formed filaments of iron pyrites, and he infers from the combination of iron and carbon at high temperatures the possibility of an igneous origin for diamond.

A paper by Messrs. Sorby and Baker was read in 1869 before the Royal Society of London, on the structure of certain minerals, among them ruby, sapphire, and diamond, showing that these gems contain cavities entirely

or partially filled with a liquid, probably condensed carbonic acid, as well as with crystals—that some emeralds contain a strong saline solution with cubic crystals, probably of chloride of potassium, and that the black specks in diamonds (such *e. g.*, as those seen in our Cudgegong mineral) are really crystals, which are sometimes surrounded by contraction cracks, a black cross appearing under polarised light. The authors conclude that the diamond does not afford positive evidence of a high temperature, though not opposed to it.

That its structure has great peculiarities has been shown by the changes produced in a yellow diamond by heat. This stone was exhibited by M. Frémy to the Académie des Sciences at Paris in 1866, when it was seen to become rose-coloured by the application of heat, returning to its proper tint on cooling. It is said to be the first instance of such a phenomenon. But, on turning to the 7th Report of the British Association, it will be seen, that in 1837, Sir David Brewster pointed out that the diamond possesses strata of different refractive powers; and he uses this as a strong argument for its vegetable origin—the changes of refraction, and, consequently, the density in parts and hardness in the same crystal being due to the action of the gases imprisoned in an expansive mass.

If we now consider the relations of the diamond to the rocks in which it is found, we shall see how great or how little is the dependence upon *them* for its origin.

A statement was made in *Nature*, February, 1870, p. 363, respecting the finding of a diamond in *granite* in the neighbourhood of Prague. It is described as exceeding in hardness the Brazilian diamonds. It was suggested to be zircon, but this Dlaschkowitz stone appears to be a veritable diamond. Its occurence in *granite* was also mentioned in the *Chemical Journal*. The statement came from Professor Schafarik, who sent it to the Bohemian paper *Politik*. On such authority it was received but not believed as authentic.

It was not till I found mention of it in an Italian publication that I discovered the mistake that had been committed. In a notice, under the head "Scoperta di Diamanti in Boemia," in No. 6 of the *Bollettino* of the *Reale Comitato Geologico d' Italia*, published in June, 1870, p. 175, we read "Fecesi questa scoperta sul finire dello scorso anno nelle vicinanze di Dlazkovic, villaggio posto tra Bilin e Lobositz, in Boemia, dove existe un giacimento di sabbie *Granatifere* lavorate per l'estrazione dei *piropi*, varietà di *granato* di un bel color rosso. Commista al prodotto della lavatura di queste sabbie, rimarcossi dai lavaratori una piccola pietra sconosciuta, durissima, e di color giallo-verdastro, che sottoposta ad esame si riconobbe essere un piccolissimo *diamante* del peso di 57 milligrammi ed in forma di esaedro a spigoli rotundati. *Dopo* di quest' epoca *altri diamanti* di simil fatta si ritrovarono, benchè assai di rado in *quelle sabbie granatifere* Quantunque sia questa scoperta di ben poca importanza, pure crediamo bene di segnalarla, essendo indubbiamente questo il *primo giacimento diamantifero che in Europa siasi trovato.*"

From this we learn that these diamonds were *not found in granite*, but in a *garnetiferous sand*, which is a new fact for *Europe*, but not for the supposed origin of diamond in a plutonic rock. I have quoted the original words to prevent mistakes as to the meaning.

(To be continued.)

ON THE

ESTIMATION OF PHOSPHORIC ACID.

By CHARLES E. MUNROE.

I. THOUGH the methods commonly in use for the quantitative determination of phosphoric acid are capable in most cases of giving accurate results, yet it will, I think, hardly be claimed for them that they render new methods unnecessary, and I have therefore undertaken the following investigation in the hope of adding something of value to our analytical resources.

My attention was first called to the employment of ferric chloride with the addition of sufficient mercuric oxide to neutralise the excess of acid. Free mercuric oxide was first added directly, but, as a complete separation could not be effected in this manner, it was found more advantageous to produce the oxide in the solution itself. This was accomplished by first adding mercuric chloride and then potassic or sodic hydrate. As sodic hydrate* can be obtained in commerce absolutely pure this was employed. The precipitate, consisting of ferric phosphate and ferric and mercuric oxides, was then evaporated to dryness in the manner recommended by Chatard,† filtered and washed on the Bunsen pump.‡ Unhappily the phosphoric acid re-dissolved after evaporation to dryness, and the process was therefore abandoned. Bunsen's delicate test with magnesium wire was used throughout the work, sometimes in connection with ammonic molybdate, for the detection of phosphoric acid.

I next studied the behaviour of aluminic oxide toward phosphoric acid, and this time met with better sucess.

The following course was pursued. To the boiling phosphate solution a weighed quantity of pure aluminic sulphate, previously dissolved, was added. A solution of mercuric chloride was then added, and finally sodic hydrate until a precipitate of mercuric oxide was obtained which remained undissolved. In order to hasten the operation the precipitate was allowed to settle and the supernatant liquid poured upon the filter. The gelatinous precipitate was then evaporated to complete dryness as before mentioned, filtered, ignited, and weighed. The increase of weight over that of the aluminic oxide used was phosphoric oxide. It was found extremely difficult to burn the filter. Care must be taken that for every grm. of phosphoric oxide at least 2 grms. of aluminic oxide are added.

The percentage of aluminic oxide, in the sulphate used, was determined by ignition, ammonic carbonate being used to drive off the last traces of sulphuric oxide. The following results were obtained:—

	Grms.		Grms.	
(1).	0·7320	$Al_2(SO_4)_3.18H_2O$ gave	0·1310	Al_2O_3 = 17·89 p. c.
(2).	0·7100	,,	0·1270	,, = 1787 ,,

Mean 17·88.

Anhydrous disodic phosphate was the first salt treated. In order to work with greater rapidity a solution of known strength was prepared of which 50 c.m.$_3$ corresponded to 0·6195 grms. of phosphate. This gave the following results:—

(1).	0·6195 grms.	gave	0·3099 grms.	P_2O_5 = 50·02 p. ct.
(2).	0·6195 ,,	,,	0·3100 ,,	,, = 50·03 ,,
(3).	0·6195 ,,	,,	0·3097 ,,	,, = 50·01 ,,
(4).	0·6195 ,,	,,	0·3097 ,,	,, = 50·01 ,,

Mean 50·02. Theory 50·00.

Ammonio-sodic phosphate ($Na(NH_4)HPo_4,4H_2O$) was next analysed. The amount of phosphoric oxide in the salt was found by igniting it and weighing the sodic metaphosphate,

	Grms.		Grms.	
(1).	1·4650	gave	0·6172	$NaPO_3$ = 29·32 per cent P_2O_5
(2).	1·5017 ,,	,,	0·6344 ,,	= 29·40 ,, ,,

Mean 29·36.

By the alumina process the following results were then obtained:—

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* The article used was manufactured in England by the direct oxidation of metallic sodium.

† *American Journal of Science*, vol. iv., p. 247.

‡ A simple modification of the Bunsen pump may be obtained by connecting a piece of glass tubing, by means of rubber, with a Bunsen funnel. A funnel holding 50 c.m.^{3} connected with a piece of glass tubing 1 metre in length emptied itself five times, while another funnel of the same capacity, arranged as usual, did so but once. The pressure was so great that the filter had to be protected with a platinum point to prevent it from giving way.

(1). 1·5405 grms. gave 0·4514 grms. P_2O_5 = 29·30 per cent
(2). 1·2610 „ „ 0·3707 „ „ = 29·39 „
(3). 1·1355 „ „ 0·3321 „ „ = 29·29 „

Mean 29·33.

Calcic phosphate did not give good results by this process on account of the difficulty of washing out the calcic sulphate formed. I succeeded no better with ammonio-magnesic phosphate; doubtless because some of the magnesia went down with the alumina. These experiments are sufficient to show that phosphoric acid may be determined with extreme precision in the alkaline phosphates by the method above given, but the method applies with advantage only to these salts. On the other hand, it must be remembered that many phosphates may be decomposed by fusion with the alkaline carbonates and the phosphoric acid then determined as above, so that in fact the method applies in perhaps the greater number of cases which occur in practice.

II. Rose's* method for the separation of phosphoric acid by means of mercurous nitrate and subsequent estimation in the form of pyrophosphate of magnesia has been much used. It will, however, be acknowledged that it has some serious defects. It is tedious, the many operations required increase the chances of error, and the fusion of mercurous phosphate with the mixed carbonates exerts, according to Rose, a sensible action upon the platinum crucible. Nevertheless the perfect separation which it gives is a strong recommendation of the method.

It appeared possible that a valuable modification of this process might result from the addition of mercuric oxide in the manner already employed in the alumina process above described.

The experiments were executed in the following manner. To a boiling solution of the phosphate mercurous nitrate was added in slight excess. This threw down a lemon-yellow coloured, crystalline precipitate of nitro-mercurous phosphate, which adhered to the sides of the beaker when touched by the stirring rod. Mercuric nitrate was then added and finally sodic hydrate until a slight precipitate of mercuric oxide was obtained which remained undissolved. The mixture of the two salts was found to be insoluble in both hot and cold water, and to wash like sand.

The next step was to find a readier means of treating the nitro-mercurous phosphate.

It was first proposed to dissolve the washed and dried precipitate in chlorhydric acid and titrate with potassic permanganate so as to oxidise the mercurous to the mercuric salt. This process failed. The salt was then treated with sulphuric acid. The final reaction was perfectly sharp, but the results were not satisfactory.

These results having proved that nothing was to be gained in that direction, I tried to remove the mercury by decomposing the nitro-mercurous phosphate with nitric acid and precipitating the mercury with sulphydric acid or ammonic sulphide. The phosphoric acid was then to be determined in the filtrate by the ammonio-magnesian solution. On examining the mercurous sulphide it was found that some of the phosphoric acid was always precipitated with it. Its presence was proved by Bunsen's test with the magnesium wire. The salt was then dissolved in a solution of potassic cyanide and a current of sulphydric acid passed through, but with the same result as before. Again it was thought that the phosphoric acid might be precipitated directly from the cyanide solution by ammonio-magnesic chloride, but experiment showed that the cyanide contained so much cyanate and carbonate that, although the solution was boiled and chlorhydric acid was added to it, accurate results could not be obtained.

As the ignition of the nitro-mercurous phosphate with the non-volatile metallic oxides, in order to drive off the mercury, promised well, this process was then tried in the following manner.

* "Traité de Chimie Analytique," vol. ii., p. 708.

The dried salt was thoroughly mixed with a weighed quantity of cupric oxide in a platinum crucible and the filter placed on top. The whole was ignited, at first gently, then to low redness, at the mouth of a muffle,* then cooled, a few drops of nitric acid added to oxidise the cupric oxide reduced by the filter, and then re-ignited. The ignition was continued until the weight became constant. The increased weight was the phosphoric oxide (P_2O_5). After ignition the cupric oxide and phosphate came out of the crucible in a beautiful coherent mass, leaving it perfectly clean and unharmed.

(To be continued).

CORRESPONDENCE.

ANALYSES OF MANURES.

To the Editor of the Chemical News.

SIR,—Mr. A. H. Church in his letter on "Agriculture and Chemistry" in the CHEMICAL NEWS for June 9, 1871, publishes an analysis of a substance sold in England as manure, and adds that the manufacturer had evidently scraped the floor a trifle too hard. I may say to Mr. Church that there are manufacturers here who do not trouble themselves to scrape the floor, but simply have recourse to the pump, when they make their "fertilisers."

I analysed a commercial manure last year which sold for 30 dollars per ton—say £5 10s. sterling—with the following result, viz:—

Water	53·5
Organic matter	21·6
Silica	1·6
Phosphate and carbonate of lime ..	23·3
	100·0

It will be apparent that as 2000 lbs. of the above "dirt" contained 1070 lbs. of water the purchaser paid for the solid matters about £11 sterling, or three quarters of the price of genuine Peruvian guano.

I may add that tricks like the above have caused a widespread distrust of artificial manures.

Peruvian guano, obtained of the importers, and this is the only manure, except flour of bone, that I use in my own horticultural experiments on a small scale, maintains its old reputation pretty well, but there are rumours afloat that even this is damped more than is needful to lay the dust.—I am, &c.,

J. M. MERRICK.

Laboratory, 59, Broad Street,
Boston, Mass., U.S.

HISTORY OF THE AMMONIA PROCESS.

To the Editor of the Chemical News.

SIR,—In your last impression is a letter with the above heading from Mr. Wanklyn, in which, in the beginning of the last paragraph, speaking of the opposition which the process for estimating the nitrogenous organic matter in water, put forth by himself and Messrs. Chapman and Smith,† met with, he says, "One chemist could, as he informed the Chemical Section of the British Association in 1867, decompose a very dilute solution of albumen so completely, by boiling it with weak solution of carbonate of soda, as to obtain the whole of its nitrogen in the

* Justice is not done the muffle furnace. It gives an even, mellow heat which can be easily regulated, and for igniting precipitates it is unequalled. I have before spoken of the difficulty found in burning the filter with the aluminic phosphate. By placing it at the mouth of the muffle I was able to ignite it in the most perfect manner, without tipping the crucible, in less than ten minutes. Discretion must be used in placing the crucible in the muffle.

† *Journ. Chem. Soc.*, vol. v., second series, p. 445 *et seq.*

form of ammonia," and as I am the chemist referred to, I trust you will allow me to say a few words upon the matter, as I clearly think that, in the way in which Mr. Wanklyn has put it, your readers would be led to suppose that my experiments had been proved wrong by similar experiments made and published by Mr. Wanklyn or his colleagues, which has not been the case.

The paper above referred to as read by me is published in your valuable journal in full,* and, since its publication, I have repeatedly made similar experiments, and I have no reason to doubt the accuracy of the conclusions I then arrived at, both as regards the actions upon the solutions containing urea and upon the solutions of albumen described in it.

The term "*weak* solution of carbonate of soda" is not mine, but Mr. Wanklyn's; my experiments were begun with 2 grms. of dry carbonate of soda to a litre of water, as in Messrs. Wanklyn, Chapman, and Smith's experiments, but as the distillation proceeds the solution gets gradually stronger and stronger, and at the end of the experiment it may, perhaps, be considered a somewhat strong solution. The experiments are so easily made, I have just now concluded one: it was made as follows:—In 1 litre of water was dissolved equal to 0·0014 grains of dry white of egg containing 0·000217 grains of ammonia, and 2 grms. of dry carbonate of soda, and this solution was put into a retort capable of holding not less than 2 litres of water, and was rapidly distilled until the distillate did not show a trace of ammonia on standing for a quarter of an hour after adding Nessler's test. The residue in the retort, distilled with hydrate and permanganate of potash, gave a distillate which yielded only the most minute trace of colour with the Nessler test, showing that the nitrogen in the albumen was practically removed from it by the previous action of the carbonate of soda upon it.—I am, &c.,

DUGALD CAMPBELL.

7, Quality Court, Chancery Lane, London,
July 12, 1871.

MISCELLANEOUS.

Publication of Abridgments of Letters Patent.—The following letter has been received by Mr. P. Spence, of the Pendleton Alum Works, Manchester, from Her Majesty's Commissioners of Patents, in reply to an influentially signed memorial of patentees, manufacturers, and others, asking an earlier publication of the abridgments, and of the "Persons" and "Subjects" indexes, hitherto always from six to eighteen months behind. By the aid of the weekly issues referred to (and which the Commissioners kindly promise to commence on the 15th inst.), it will be perceived that any inventor, manufacturer, or other interested party, will be enabled henceforth to refer with ease and certainty to the latest patented improvements in any given field:—

"Patent Office, July 5th, 1871.

"Sir,—Your letter of May 12th and accompanying memorial were considered by the Commissioners of Patents at their meeting on the 29th ult., and I have now the pleasure to acquaint you that they decided to comply with the wishes of the memorialists. The abridgements furnished by the applicants for letters patent will therefore be published weekly with indexes of Persons and Subjects, commencing on Friday, July 15th, with the abridgements delivered between 1st and 7th of January, and of which the six months' term would expire between the 1st and 7th of July. Will you be so good as to communicate this information to the gentlemen who signed the memorial. —I am, sir, your obedient servant, B. WOODCROFT, Clerk to the Commissioners of Patents."

* CHEMICAL NEWS, vol. xvi., p. 139 *et seq.*

Meat Preserving.—Many methods have been introduced to meet the ever-growing want of England—cheap animal food. Some of these methods have been successful, and others the reverse. We could ill spare the little that is already placed at our disposal by Australian and other meat companies; and the highly remunerative character of investments in the preserved-meat trade affords a sure guarantee for greater efforts in the future than any that have hitherto been made. Liebig's process has been carried on very profitably at home as well as abroad; but the preparation of extract of meat has been declared wasteful from the small amount of stimulating material preserved, and the carting away of all albumenoid matters to the manure-heap. A new plan has been introduced by an engineer, whose experience in sugar refineries and other extensive works in hot latitudes has ensured a practical and economical solution of one of the most important problems of the day. Mr. T. F. Henley does away with steeping meat in water, and with boiling and otherwise treating it in the most costly way. He simply squeezes a definite amount of juice out of the fibre, and by mechanical desiccation preserves the latter intact. The pressed meat thus obtained contains 10 per cent of alcoholic extract and salt, and over 50 per cent of fibrin and other albumenoid constituents. It is exceedingly rich, and so is the meat-juice which Mr. Henley evaporates in vacuum pans. The juice contains about 15 per cent of alcoholic extract, and over 50 per cent of albumen. The ancient method of abstracting water only from the animal matter is relied on as the preservative, and the low temperature at which the evaporation is carried on prevents any loss of flavour or other deterioration. It is perhaps strange that so cheap and simple a process should not have been suggested before. Mr. Henley has worked at it for some time, and perfected it so as to ensure its immediate adoption. The first works, on an extensive scale, are to be opened in the River Plate, on the Estancia Nueva Alemania, where cattle have been reared and fattened for the European markets. It is proposed to slaughter three hundred bullocks daily; and since it is stated that the hides and feet pay the first cost of the bullock and of its slaughtering, the financial prospects of the undertaking wear a promising aspect.—*British Medical Journal.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, June 5, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

New Method for Measuring Magnetism in Mechanical Units.—A. Cazin.—An algebraico-physical paper.

New Facts concerning Selenium.—P. Guyot.—The author draws the following conclusions from his experiments:—(1) Selenium, dissolved in sulphide of carbon, does not precipitate any other acid salts than nitrate of silver; (2) among the neutral salts, also, none but the silver salt just alluded to are precipitated by the aforesaid solution; (3) the solution alluded to precipitates some metals in alkaline solution, since there is seleniuretted hydrogen formed, which acts upon these solutions; (4) all these precipitates are seleniurets; (5) with iodine, proto-iodide of selenium in a crystalline form is obtained.

New Liquid Fire.—P. Guyot.—When to flowers of sulphur in excess bromine is added, and this mixture, after having been left

standing for a while in a glass-stoppered bottle, filtered through asbestos, there is obtained a liquid which, on analysis, was found to consist, in 100 parts, of 83·33 of bromine and 16·77 of sulphur, being, therefore, proto-bromide of sulphur. This liquid, when brought into contact with liquid ammonia, appears at first inert, but after a few minutes the mixture boils violently and bursts into flame. The author describes at length his experiments which led to the following results:—Bromide of sulphur behaves in the presence of ammonia like chloride of sulphur, but the reaction with the bromide is not instantaneous; the bromide of sulphur may be employed for the purpose of producing liquid fire, to which the author gives the name of *nouveau feu lorrain*. The reader is reminded that, in 1869, the late J. Nicklès, at Nancy, discovered a composition for a liquid fire which obtained the name of *feu lorrain*. The use of the bromide of sulphur is more safe, but all attempts made by the author to bring this mixture, by various means, into a more manageable pasty mass have failed.

Dynamite.—P. Guyot.—The main gist of this paper is the communication of an observation which is not by any means unimportant. The substance known as dynamite (consisting essentially of nitroglycerine absorbed by any suitable inert powder) is met with in the trade made up in cartridges weighing, on an average, 71 grms., and packed in boxes weighing, with contents, about from 25 to 30 kilos. The author, happening to have in his possession a number of cartridges containing dynamite (the body of the cartridge is made of stout grey paper), found that these objects, after some lapse of time, became moist and oily looking, and a cardboard box in which the cartridges were kept was also found impregnated with a liquid, which, on investigation, turned out to be nitroglycerine. A small piece of the paper so impregnated exploded violently when brought into contact with glowing coals, and the like effect was observed when a piece of the paper was laid upon an anvil and smartly struck with a hammer. The author also found that the wood of the boxes in which dynamite cartridges are kept becomes, by slow degrees, impregnated with nitroglycerine, and thereby a most dangerously explosive material, which may give rise to serious accidents in warehouses where dynamite is kept.

June 12, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and allied sciences:—

Memoir on the Celestial Origin of Atmospheric Electricity. M. Becquerel.—This very lengthy essay is, notwithstanding its high intrinsic value, not well suited for any useful abstraction, an observation which also applies to the two following papers.

Note on Simple Relations Existing between the Pressure of Aqueous Vapour and the Temperature.—J. G. Duperray.

Physical Constitution of the Sun.—A. Boillot.

Establishment of a Meteorological Observatory on the Azores.—Dr. Buys-Ballot.—After briefly pointing out the great importance, not simply in a scientific, but also in a mercantile and industrial point of view, of having, on one of the islands just named (they belong to Portugal, and are situated at about 40° N. lat., and 30° W. of Greenwich), a meteorological station, connected by submarine telegraphs with Europe and America. The author states that probably by September, 1872, this desirable object will be accomplished by the activity of M. Fradesso da Silveira, the Director of the Observatory at Lisbon.

June 19, 1871.

This number contains the following original papers and memoirs relating to physico-chemical sciences:—

Low Temperature of the 18th of May last and of the first days of June.—Ch. Sainte-Claire Deville.—From the contents of this lengthy paper, containing a series of communications received by the author from different localities in France, it appears that, even in the very south of that country, the temperature fell during this period to so low a degree as has not been witnessed within man's memory at this time of the season; moreover, heavy storms, accompanied by deluging rains and seriously destructive hail, have occurred in many parts of France; while near Paris, at St. Germain en Laye, the author found the temperature was −3·5° on the 18th of May, in the morning, at a height of 33 centimetres above the soil (a meadow).

Alteration which the Yellow Metal employed for Coppering (as it is technically termed) Wooden Ships undergoes, and on the means of ascertaining the nature thereof beforehand.—A. Bobierre.—After referring to his former labours on this subject (see *Ann. de Chim. et de Phys.*, 4th series, vol. xv.), the author in this memoir states chiefly that the effects of wear and tear (slow dissolving of the metal by the aid of an electric current) are only applicable under the following restrictions:—The alloy to be tested should be previously acted upon by an acid (*décapé*); a chemical analysis of the alloy is also necessary in order to ascertain its precise composition, and for the purpose of ascertaining the impurities it may contain. Lastly, it is necessary to know whether or not the metal was rolled out while red-hot.

Dissociation as Viewed Thermodynamically.—J. Moutier.

Heat Produced by the Combustion of Magnesium and Zinc.—A. Ditte.—Are both algebraico-physical memoirs.

Researches on the Formation of Gallic Acid.—M. Sacc.—The author points out that, if the theory usually accepted for the mode of formation of gallic acid (which, according to Pelouze's experiments, has the formula $C_7H_6O_5$, and is derived from tannic acid simply by its splitting up into sugar and gallic acid in the presence of water) be correct, there ought to be obtained a smaller quantity, by weight, of gallic acid from a given quantity of tannic acid used. That this does not so happen has been proved already by Dr. Stenhouse, who found that tannic acid, while being converted into gallic acid, yields its own weight of the latter. The author of this paper, having made a series of experiments on this subject, found that tannic acid, while being converted into gallic acid, increases considerably in weight, and concludes that hydratation there takes place, and that accordingly tannic acid is only the anhydride of gallic acid.

Use of Gaize for the Preparation of Alkaline Silicates.—A. Scheurer-Kestner.—After referring to the memoir on gaize (a peculiar mineral found in some parts of France), by Sainte-Claire Deville and Desnoyer (see *Comptes Rendus*, vol. lxx., p. 581), the author communicates, at length, a series of experiments instituted by him with a gaize, composed, in 100 parts, of—Hygroscopic water, 3·4; water of combination, 3·2; silica soluble in alkaline solutions, 43·7; insoluble silica, 40·8; alumina, 3·8; ferric oxide, 3·8; lime, 0·9. The results of the author's experiments are that gaize, boiled for a length of time with caustic soda, yields a silicate, $Si_2Na_4H_8O_{16}$; that boiling under pressure at 150° does not yield a better result, and that therefore it is not likely that gaize may be industrially employed for the preparation of alkaline silicates by being simply boiled with caustic soda.

Use of Dynamite for the Purpose of Breaking Up Heavy Masses of Cast-Iron.—P. Champion.—This paper records, at considerable length, the results of some experiments made upon an anvil belonging to a steam hammer, and weighing over 5 tons, which was broken up into lumps of suitable size for the purpose of being smelted down by the aid of two small charges of dynamite.

Experimental Researches on the Constitution of Blood and on the Nutrition of Muscular Tissue.—W. Marcet.

This number contains, also, a series of papers bearing upon meteorology.

Revue des Cours Scientifiques de la France et de l'Etranger, (2nd series), No. 1, July 1, 1871.

This number does not contain any original papers relating to chemistry and allied sciences.

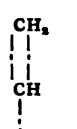
Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 10, 1871.

This number contains the following original papers and memoirs:—

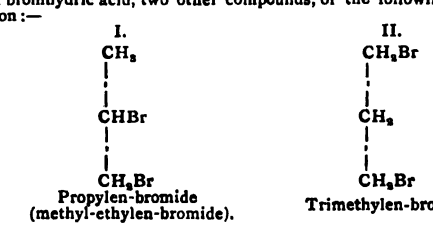
Density (Sp. Gr.) of the Elements Compared with the Density of their Oxides.—H. Ludwig.—In order to give some idea of the main contents of this lengthy paper, we quote the following examples from its contents:—Light elements—viz., those the oxides of which are heavier than the elements themselves—Hydrogenium, solid, sp. gr. 0·733 (T. Graham), water, sp. gr. 1·000; silicium, sp. gr. at 10°, 2·49 (F. Wœhler), silica, sp. gr. at 4°, 2·652 (Dumas and Lecoyer); the oxides of these elements exhibit neither an acid nor alkaline reaction, and consequently correspond in that respect with those of the earthy metals. Potassium, sp. gr. 0·865 (Gay Lussac and Thénard); potassa, sp. gr. 2·656 (Karsten). In this manner twenty elements are named and proved to belong to the class of light elements. The opposite class, heavy elements, contains, according to the author, oxygen, the haloids, selenium, sulphur, nitrogen, &c., forty-one in number.

Observations on the Constitution of Rosaniline.—H. Baumhauer.—The value of the contents of this paper depends upon the diagrams representing the constitutional formula of rosaniline, first as represented by Dr. Kekulé in his work "Chemie der Benzol Derivate," vol. i., p. 180, and next as modified by this author.

Contribution to our Knowledge on the Constitution of the Allyl Compounds.—F. Geromont.—The author states that, starting from the proposition that the constitutional formula of allyl-bromide (*allyl-bromür*) should be—



he succeeded in preparing from allyl-bromide, by the addition thereto of bromhydric acid, two other compounds, of the following constitution:—



I. Propylen-bromide (methyl-ethylen-bromide).

II. Trimethylen-bromide.

This reaction takes place readily when concentrated hydrobromic acid is used, and the operation performed in sealed tubes. At 100°, the two bodies the formula of which has just been quoted are separated from each other by fractioned distillation. The trimethylen-bromide forms about two-thirds of the entire crude fluid first obtained; after

having been purified, the sp. gr. of this body was found to be, at 0°, 2·0177; its boiling-point, 160°—163°. By the action of acetate of silver, aided by glacial acetic acid, the trimethylen-bromide is converted into acetic acid-trimethylenester (*essigsäure-trimethylenester*), a colourless heavy liquid, boiling at from 203° to 205°, and yielding, on being saponified with hydrate of baryta, trimethylen-glycol.

On Umbelliferon.—H. Hlasiwetz.—The substance was just named was first discovered by Zwenger and Sommer (*Ann. Chem. Pharm.*, vol. cxxxix., p. 99) in the bark of *Daphne mezereum*, and was next found by them in the products of the dry distillation of several resins derived from plants belonging to the natural order of the *Umbelliferæ*, umbelliferon being best obtained from the galbanum resin. The main portion of this essay is devoted, however, to a discussion bearing upon the constitutional formula of umbelliferon in reference to the recent researches on æsculetin (CHEMICAL NEWS, vol. xxiii., p. 275) by H. Schiff. Taking into consideration the behaviour of umbelliferon to acetyl-chloride, the author of this paper gives, for the body just alluded to, and æsculetin and para-æsculetin, the following formulæ:—

$C_9H_2\begin{cases}CH.O\\CH.O\\C.OH\\H\end{cases}$	$C_9H_2\begin{cases}CH.O\\C.OH\\C.OH\\OH\end{cases}$	$C_9H_2\begin{cases}CH.O\\CH.O\\CH.O\\O\end{cases}$
Umbelliferon.	Æsculetin.	Para-æsculetin.

When an alkaline solution of umbelliferon is treated with sodium-amalgam, there is obtained umbellic acid, $C_9H_{10}O_4$, which is readily converted into resorcine, which is also directly formed from umbelliferon by the action of strong caustic potassa solution upon that body at a higher temperature.

Researches on the Constitution of the Benzol Derivatives.—V. von Richter.—This is the second instalment of an essay on this subject. According to this author, the three isomeric series of the benzol derivatives may be represented as follows:—

$C_6H_4\begin{cases}Br\\NO_2\end{cases}$	$C_6H_4\begin{cases}Br\\NO_2\end{cases}$	$C_6H_4\begin{cases}Br\\NO_2\end{cases}$
(Boils at 125°.)	(Boils at 256°.)	(Boils at 327°.)
Orthonitrophenol.	Dinitrobenzol.	Volatile nitrophenol.
Chinon.	Resorcin.	Pyrocatechin.
Ortho-oxybenzoic acid.	Salicylic acid.	Para-oxybenzoic acid.

New Class of Dyes.—A. Baeyer.—The author first refers to his former paper on gallein (CHEMICAL NEWS, vol. xxiii., p. 275). The composition of this substance was, on analysis, found to be $C_{19}H_{14}O_7$. When treated with zinc and dilute sulphuric acid, gallein is converted into gallin, a solid, colourless, crystalline substance, soluble in ether, and, better yet, in an aqueous solution of pyrogallic acid. Gallin, dried in vacuum, was found, on analysis, to lead to the formula $C_{18}H_{16}O_6$; it is difficultly soluble in cold, but readily soluble in boiling water, and very readily in alcohol. Gallin exhibits great similarity to hæmatoxylin, with which it also shares the property of becoming readily pink-coloured, both in solid state and in solution; it (gallin) dyes tissues in the same manner as gallein. When this last-named body is treated with concentrated sulphuric acid at 200°, cöruleine is obtained, the formula of which is $C_{18}H_{10}O_6$, its mode of derivation from gallein being expressed by—

$$\underbrace{C_{18}H_{14}O_7}_{\text{Gallein.}} - H_2O - H = C_{18}H_{10}O_6.$$

Cöruleine is difficultly soluble (almost insoluble) in water, alcohol, and ether; it dissolves more readily in acetic acid, yielding a dirty green-coloured solution. In hot aniline it is readily soluble, the solution exhibiting a magnificent indigo-blue colour; this solution, slightly acidified with acetic acid, dyes wool indigo-blue. Cöruleine dissolves in alkaline solutions, exhibiting a beautiful green colour: tissues mordanted with alumina are dyed green by this solution, while, if mordanted with iron compounds, a brown colour is the result. These dyes are fast, and resist soapsuds. The author points out that there is a great similarity between cöruleine and the lo-kao, Chinese green. By the aid of reducing agents, cöruleine is converted into cörulin, soluble in ether, and yielding a yellow-coloured solution. By the action of phthalic acid anhydride upon resorcine, fluoresceine is formed, a yellowish-red coloured body, soluble in alcohol; this substance dyes silk and wool yellow without the aid of any mordant. When fluoresceine is heated with reducing agents, it is converted into fluorescine, which, on being treated with chromic acid, becomes again fluoresceine.

Action of Hydriodic Acid upon Hydrophthalic Acid.—K. Mizerski.—When hydrophthalic acid is submitted, along with hydriodic acid, in a sealed tube, to a temperature of from 240° to 250° for about six hours, the main product of this reaction (about 60–65 per cent) is found to be hexa-hydrophthalic acid, $C_8H_{14}O_4$, exactly identical with the substance obtained by Dr. A. Baeyer from tetra-hydrophthalic acid, agreeing therewith also as regards its melting-point (207°).

Les Mondes, June 29, 1871.

This number does not contain any original papers relating to chemistry and collateral sciences; but we meet herein with a short scientifico-biographical notice on—

The Late Professor Payen.—P. Thomas.—The author, the nephew of the deceased, states that the eminent *savant* died lately of apoplexy. As regards the very varied and immense mass of researches and discoveries made by the deceased, the following brief instances are quoted:—In 1824, he was the first who pointed out the rational method of applying manures in agriculture, and about the same time brought forward the theory of the decolouration of liquids by animal charcoal, also suggesting the use of the residues of the sugar refining (scums which contain more or less animal charcoal along with other substances) in agriculture. In 1830, he laid the foundation of the proper valuation of manures according to their richness in nitrogen. The late author's exhaustive researches on amylaceous matter settled the exact structure, mode of formation, and the derivation of dextrine and glucose from starch; the existence of diastase, also, was first pointed out by the deceased. Prof. Payen, very well known, also, among a great many others, by his excellent work on industrial chemistry, "Précis de Chimie Industrielle" (Paris: Hachette and Co., 1867), was, since 1842, a member of the French Academy of Sciences, and held the Professorships of Industrial Chemistry at the Ecole Centrale des Arts et des Manufactures since 1830, and at the Conservatoire des Arts et Métiers since 1839. The deceased was not only a very eminent scientific man, but was thoroughly and practically acquainted with almost every branch of industrial pursuits. Anselme Payen was born at Paris on January 17th, 1795, and was in early life first the technical manager of a beet-root sugar work at Vaugirard, and afterwards of a very large chemical work near Paris.

July 6, 1871.

Among the great variety of matter contained in this number, including political subjects, the only original communication which belongs to chemico-physical science is—

University of Cordova, Argentine Republic, South America.—The Government of the country alluded to has just added to its University (hitherto only consisting of two faculties—viz., law and divinity) a faculty of sciences, of which Dr. Burmeister, the celebrated author of the work bearing title "Geschichte der Schöpfung," and hitherto Director of the Museum at Buenos Ayres, has been appointed the Dean, while the following gentlemen have been appointed to the chairs placed after their names:—Dr. Stelzner, mineralogy and geology; Siewert (from Halle), chemistry; Lorenz (from Munich), botany; Holzmuller (from Merseburg), mathematics; Gould (from the United States), astronomy. For the chairs of natural philosophy and zoology, it is also expected to find amongst the scientific men of Germany gentlemen who will be willing to take these positions. The Argentine Republic has a superficial area of 515,700 English square miles, with barely 2,000,0000 inhabitants. Cordova is a city with 25,000 inhabitants, and is rather centrally situated.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 5, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences;—

Adulteration of Roasted Chicory with Pulverised Peat.—Dr. Th. Swartz.—After referring to the circumstances which caused this investigation, the author states that his process for the detection of this gross fraud, though not injurious to health, is based upon the following points:—Since peat is a fossil combustible, due to the spontaneous decomposition of woody matter, and since among these products are found hydrocarbons belonging to the germs petroleum, ozokerite, paraffin, fossil wax, &c., these substances have been searched for by the author among peat. This, having been treated with chloroform, yields from 4 to 5 per cent of a bituminous matter, which, after having been purified, presents unmistakable characters. Chicory, not adulterated with peat, does not, of course, yield any similar substance. Peat, being in a great measure produced by partly-decayed plants, remnants of *Sphagnum*, *Hypnum*, and *Decranum* may be discovered among chicory adulterated with peat by the aid of the microscope. Peat yields, on average, from 8 to 10 per cent of ash, and if of very old formation, even as much as 20 per cent; while chicory does not, in its natural, pure, unadulterated state, yield more than from 4 to 6 per cent of ash, provided, previous to roasting, the roots have been well cleaned and freed from adhering sand and soil. To this paper is added an excellently executed number of engravings representing the microscopic structure of the plants above alluded to, and also that exhibited by pure chicory.

Preservation of Meat.—Dr. Melsens.—Samples of meat preserved in contact with air for a period of more than two years, were exhibited at the meeting of this Academy by the author, who, however, did not explain anything concerning the process whereby this result was obtained; but to the samples were added affidavits from competent judges—among whom were veterinary surgeons and the sanitary veterinary inspector of the abattoirs at Bruxelles—confirming the facts and certifying to the good quality of the meat after having been kept for so long a period of time.

The other papers in this number relate to botany and paleontology.

Journal für Gasbeleuchtung und Wasserversorgung, No. 10, 1871.

In addition to a series of very important papers directly bearing upon gas and waterworks' engineering and management, this number contains the following matter relating to chemistry:—

Influence the Water Supplied to Dantzig has on Leaden Pipes.—Dr. Lissauer.—After referring to some subjects only of local interest, the author states that it may be taken as a general rule that,

with soft water, leaden pipes, during the first four or five weeks after having been laid on, contaminate such water with lead, but afterwards, a strongly adhering coating of oxide of lead having been formed inside the pipes, no further danger is to be apprehended. As soon as water contains 58 milligrms. of carbonate of lime per litre, kept in solution by carbonic acid, leaden pipes are not acted upon.

Method of Improving Spring Water.—Dr. Schilling.—The sides and bottom of the well should be made perfectly watertight by means of masonry. Into the bottom wall is to be inserted a glazed earthenware tube or pipe, some feet in length, care being taken to cement it watertight into the bottom masonry; this tube should be filled, first with a layer of clean pebbles, next a layer of coarsely granulated charcoal, and next a layer of fine, white, clean sand, or other suitable filtering materials, through which the water of the well is forced to pass upwards, being thereby purified. The author states that the cleansing, renewing, of the filtering materials will have to be occasionally attended to; but it is clear that this operation, supposing the well to give, as desired, a constant and large supply of water, cannot be easily brought into actual practice.

Zeitschrift für Chemie von Beilstein, No. 7, 1871.

This number contains the following original papers and memoirs:—

Action of Chlorine upon Ethyl-Chloride.—W. Staedel.—This paper contains the abstract of an account of a series of experiments on the chlorine substitution products of ethyl-chloride made and published by the author some years ago, care having been taken to arrange the conditions of the experiments in such a manner as to obtain only the lower chlorinated products. The main contents of this paper bear upon the differences of results obtained by the author and by other experimenters on this same subject, and relate chiefly to the boiling-points of some of the substances obtained.

On Para-Sulpho Benzoic Acid.—I. Remsen.—After briefly referring to his researches on para-oxybenzoic acid (CHEMICAL NEWS, vol. xxii., p. 228), the author, in this paper, gives an account of some researches made in order to verify the correctness of his view that crude sulpho-benzoate of potassium contains two isomeric salts. For this purpose, the acid of that salt was set free, and next combined with baryta. This compound was repeatedly purified and re-crystallised; it lost its water of crystallisation at from 250° to 260°. The analysis of the salt led to the formula $(C_{14}H_{10}S_2O_{10})Ba+3H_2O$. The mother-liquor of the crystals of the salt just alluded to yielded another baryta salt of a different crystalline structure. Both of the salts here spoken of, having been converted again into potassium salts, the author found that the first-mentioned baryta salt yielded, on being fused with caustic potassa, pure para-oxybenzoic acid, accordingly proving that the baryta salt, the formula of which is above mentioned, is a salt of para-sulpho benzoic acid. Acid para-sulpho benzoate of barium is very difficultly soluble in hot water; it crystallises immediately on cooling. The neutral potassa salt of this acid is readily soluble in hot as well as in cold water; the chief product of the action of sulphuric acid upon benzoic acid is, therefore, meta sulphobenzoic acid, while some para-sulphobenzoic acid is also formed.

On Olibanum.—A. Kurbatow.—The author first refers to the researches on this subject made by Dr. Ste... ouse (*Ann. Chem. Pharm.*, 35, 306 (1870). According to these experiments, olibanum consists of resin, gum, and an ethereal oil having the formula $C_{25}H_{28}O$. The author of this paper, having repeated Dr. S.'s researches, found that the ethereal oil of encens, boiling at 162°, yields, when submitted to fractioned distillation, an oil not containing oxygen (the crude oil contains that element) boiling at 160°, and another oil which boils at 175°, and contains oxygen. The first-named body—the main bulk of the oil—is termed by the author oliben, $C_{10}H_{16}$, (sp. gr. at 12°, 0·863); it is soluble in alcohol and ether, and is resinified by nitric acid: the other portion, which boils at 175°, contains, percentically—C, 83·55; H, 5·57; rest upon 100 being O; does not yield, when treated with sodium, any hydrocarbon. Oliben absorbs, while becoming brown-coloured, hydrochloric acid gas, and yields a camphor-like solid substance which fuses at 127°. Formula, $C_{10}H_{16}.HCl$. The resinous matter contained in the encens, previously deprived of its essential oil, is soluble in alcohol, brown-coloured, brittle, very readily fusible; it contains, in addition to oxygen, upon 100 parts, C, 76·96; H, 10·97. The resin submitted to distillation yields chiefly a compound, $C_{10}H_{16}$.

Dinitro-Aniline.—W. Rudnew.—The author describes, in catalogical order, and briefly:—Dinitro-acetanilid, $C_6H_3(NO_2)_2.NH(C_2H_3O)$, soluble in boiling water and cold alcohol, fuses at 120°, crystalline; dinitro-aniline, $C_6H_3(NO)_2.NH_2$, a greenish-yellow coloured powder, insoluble in cold and boiling hot water, tolerably well soluble in boiling alcohol, fuses at 175°; dinitro-citraconanil, $C_4H_3(NO_2)_2.N(C_5H_4O_2)$, not at all soluble in water and not in cold alcohol, readily so in that liquid when boiling, crystalline, fusing at 120°.

Action of Water upon Chloride of Antimony.—A. Sabanijen.—This paper treats mainly on the composition of the so-called algaroth powder, oxychloride of antimony, and on the mode of its formation, and the influence of time and temperature thereupon. The oxychloride here alluded to, $Sb_4Cl_2O_5$, is a crystalline material obtained, as is well known, by adding water to chloride of antimony, if cold be taken 30 times the bulk of the chloride, if hot 3 times, care being taken to keep the liquid at about 65° for several hours after the addition of the water to the chloride.

Volumetrical Estimation of Copper in Brass.—M. Kirpitschow.—The main results of the researches recorded in this paper may be summarised as follows:—The titration of an ammoniacal solution of brass with Na_2S is equally correct as if copper alone were present. A little more Na_2S (0·3 c.c.) is required than with pure copper, but this quantity is a constant one, amounting to about 1·5 per cent, and does not depend on the quantity of zinc which is present, since that metal is not acted upon by the Na_2S until after the precipitation of all the copper.

Isomeric Dibromtoluols.—E. Wroblevsky.

Some of the Conversions of Isomeric Bromtoluidines.—E. Wroblevsky.—This and the preceding paper are, as regards their contents, papers recording, in catalogical order, a series of names and formulæ of bodies not well suited for any useful abstraction.

Mono- and Dinitro-Naphthaline.—Drs. F. Beilstein and A. Kuhlberg.—Mono-nitro-naphthaline, prepared by the action of strong crude nitric acid upon naphthaline, is readily soluble in sulphide of carbon, difficultly in alcohol, crystalline, and fuses at 58·5. Nitro-amido-naphthaline, $C_{10}H_6(NO_2)(NH_2)$; the sulphate of this base, $[C_{10}H_6(NO_2)(NH_2)]_2H_2SO_4+2H_2O$, is difficultly soluble in cold water, and loses its water of crystallisation by standing over sulphuric acid under a bell-jar; the free base, $C_{10}H_6(NO_2)(NH_2)$, is a red-coloured crystalline body, fusing at 118°. The authors conclude, from their experiments, that—(1) Naphthaline behaves in a manner analogous to benzol; and (2) that in the α dinitro-naphthaline the two nitro-groups are symmetrically placed. α dinitro-naphthaline is not acted upon by a concentrated and hot mixture of sulphuric acid and bichromate of potassa.

TO CORRESPONDENTS.

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Alkali.—A table for the percentage estimation of the carbonate of calcium contained in animal charcoal, calculated from the volume of the carbonic acid, will be found in "Select Methods in Chemical Analysis," by W. Crookes, F.R.S. (Longmans). We know of no other published tables connected with Dr. Schiebler's calcimeter.

S. E. Phillips.—We do not remember the dates. Consult the Index from vol. xx.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 608..

ON DUST AND SMOKE.*

By JOHN TYNDALL, LL.D., F.R.S.,
Professor of Natural Philosophy, Royal Institution.

AFTER a few preliminary experiments illustrative of the polarisation of light, Professor Tyndall adverted to the polarisation of light by fine dust, by the sky, and by the coarser particles of smoke. In the former the direction of maximum polarisation, as in the case of the sky, is at right angles to the illuminating beam. In the latter, according to the observations of Govi, the maximum quantity of polarised light was discharged obliquely to the beam. Govi's observation of a neutral point in such beam, on one side of which the polarisation was positive and on the other side negative, was also referred to. The additional fact was then adduced that the position of the neutral point varied with the density of the smoke. Beginning, for example, with an atmosphere thickened by the dense fumes of incense, resin, or gunpowder, and observing the neutral point, its direction was first observed to be inclined to the beam *towards* the source of illumination. Opening the windows so as to allow the smoke to escape gradually, the neutral point moved down the beam, passed the end of a normal drawn to the beam from the eye, and gradually moved forward several feet down the beam. The speaker did not halt at these observations; they were introduced as the starting-point of inquiries of a different nature, and after their introduction the discourse proceeded thus:—

But what, you may ask, is the practical good of these curiosities? And if you so ask, my object is in some senses gained, for I intended to provoke this question. I confess that if we exclude the interest attached to the observation of new facts, and the enhancement of that interest through the knowledge that bye-and-bye the facts will become the exponents of laws, these curiosities are in themselves worth nothing. They will not enable us to add to our stock of food, or drink, or clothes, or jewellery. But though thus shorn of all usefulness in themselves, they may, by leading the mind into places which it would not otherwise have entered, become the antecedents of practical consequences. In looking, for example, at this illuminated dust, we may ask ourselves what it is. How does it act, not upon a beam of light, but upon our own lungs and stomachs? The question at once assumes a practical character. We find on examination that this dust is organic matter—in part living, in part dead. There are among it particles of ground straw, torn rags, smoke, the pollen of flowers, the spores of fungi, and the germs of other things. But what have they to do with the animal economy? Let me give you an illustration to which my attention has been lately drawn by Mr. George Henry Lewes, who writes to me thus:—

"I wish to direct your attention to the experiments of Von Recklingshausen should you happen not to know them. They are striking confirmations of what you say of dust and disease. Last spring, when I was at his laboratory in Würzburg, I examined with him blood that had been three weeks, a month, and five weeks, out of the body, preserved in little porcelain cups under glass shades. This blood was living and growing. Not only were the Amœba-like movements of the white corpuscles present, but there were abundant evidences of the growth and development of the corpuscles. I also saw a frog's heart still pulsating which had been removed from the body (I forget how many days, but certainly more than a week). There were other examples of the same persistent vitality or absence of putrefaction. Von Recklingshausen did not attribute this to the absence of germs—germs were not mentioned by him; but when I asked him how he represented the thing to himself, he said the whole mystery of his operation consisted in keeping the blood *free from dirt*. The instruments employed were raised to a red heat just before use, the thread was silver thread and was similarly treated, and the porcelain cups, though not kept free from air, were kept free from currents. He said he often had failures, and these he attributed to particles of dust having escaped his precautions."

Professor Lister, who has founded upon the removal or destruction of this "dirt" great and numerous improvements in surgery, tells us the effect of its introduction into the blood of wounds. He informs us what would happen with the extracted blood should the dust get at it. The blood would putrefy and become fetid; and when you examine more closely what putrefaction means, you find the putrefying substance swarming with organic life, the germs of which have been derived from the air.

Another note which I received a day or two ago has a bearing particular significant at the present time upon this question of dust and dirt, and the wisdom of avoiding them. The note is from Mr. Ellis, of Sloane Street, to whom I owe a debt of gratitude for advice given to me when sorely wounded in the Alps. "I do not know," writes Mr. Ellis, "whether you happened to see the letters of which I enclose you a reprint, when they appeared in the *Times*. But I want to tell you this in reference to my method of vaccination as here described; because it has, as I think, a relation to the subject of the intake of organic particles from without into the body. Vaccination in the common way is done by scraping off the epidermis, and thrusting into the punctures made by the lancet the vaccine virus. By the method I use (and have used for more than twenty years) the epidermis is lifted by the effusion of serum from below, a result of the irritant cantharadine applied to the skin. The little bleb thus formed is pricked, a drop of fluid let out, and then a fine vaccine point is put into this spot, and after a minute of delay it is withdrawn. The epidermis falls back on the skin, and quite excludes the air—and not the air only, but what the air contains.

"Now mark the result—out of hundreds of cases of re-vaccination which I have performed, I have never had a single case of blood-poisoning or of abscess. By the ordinary way the occurrence of secondary abscess is by no means uncommon, and that of pyæmia is occasionally observed. I attribute the comparative safety of my method entirely, first, to the exclusion of the air and what it contains; and, secondly, to the greater size of the apertures for the inlet of mischief made by the lancet."

I bring these facts forward that they may be sifted and challenged if they be not correct. If they are correct it is needless to dwell upon their importance, nor is it necessary to say that if Mr. Ellis had resigned himself wholly to the guidance of the germ theory he could not have acted more in accordance with the requirements of that theory than he has actually done. It is what the air contains that does the mischief in vaccination. Mr. Ellis's results fall in with the general theory of putrefaction propounded by Schwann, and developed in this country with such striking success by Professor Lister. They point, if true, to a cause distinct from bad lymph for the failures and occasional mischief incidental to vaccination; and if followed up they may be the means of leaving the irrational opposition to vaccination no ground to stand upon, by removing even the isolated cases of injury on which the opponents of the practice rely.

We are now assuredly in the midst of practical matters. With your permission I will recur once more to a question which has recently occupied a good deal of public attention. You know that as regards the lowest forms of

* A Lecture delivered at the Royal Institution of Great Britain, June 9, 1871.

life, the world is divided, and has for a long time been divided, into two parties, the one affirming that you have only to submit absolutely dead matter to certain physical conditions to evolve from it living things; the other, without wishing to set bounds to the power of matter, affirming that in our day no life has ever been found to arise independently of pre-existing life. Many of you are aware that I belong to the party which claims life as a derivative of life. The question has two factors:—the evidence, and the mind that judges of the evidence; and you will not forget that it may be purely a mental set or bias on my part that causes me throughout this discussion from beginning to end, to see on the one side dubious facts and defective logic, and on the other side firm reasoning and a knowledge of what rigid experimental inquiry demands. But judged of practically, what, again, has the question of Spontaneous Generation to do with us? Let us see. There are numerous diseases of men and animals that are demonstrably the products of parasitic life, and such diseases may take the most terrible epidemic forms, as in the case of the silkworms of France in our day. Now it is in the highest degree important to know whether the parasites in question are spontaneously developed, or are wafted from without to those afflicted with the disease. The means of prevention, if not of cure, would be widely different in the two cases.

But this is by no means all. Besides these universally admitted cases, there is the broad theory now broached and daily growing in strength and clearness—daily, indeed, gaining more and more of assent from the most successful workers and profound thinkers of the medical profession itself—the theory, namely, that contagious disease generally is of this parasitic character. If I had heard or read anything since to cause me to regret having introduced this theory to your notice more than a year ago, I should here frankly express that regret. I would renounce in your presence whatever leaning towards the germ theory my words might then have betrayed. Let me state in two sentences the grounds on which the supporters of the theory rely. From their respective viruses you may plant typhoid fever, scarlatina, or small-pox. What is the crop that arises from this husbandry? As surely as a thistle rises from a thistle-seed, as surely as the fig comes from the fig, the grape from the grape, the thorn from the thorn, so surely does the typhoid virus increase and multiply into typhoid fever, the scarlatina virus into scarlatina, the small-pox virus into small-pox. What is the conclusion that suggests itself here? It is this:—That the thing which we vaguely call a virus is to all intents and purposes a *seed;* that, excluding the notion of vitality, in the whole range of chemical science, you cannot point to an action which illustrates this perfect parallelism with the phenomena of life—this demonstrated power of self-multiplication and reproduction. The germ theory alone accounts for the phenomena.

And here you see the bearing of the doctrine of Spontaneous Generation upon this question. For if the doctrine continues to be discredited as it has hitherto been, it will follow that the epidemics which spread havoc amongst us from time to time are not spontaneously generated, but that they arise from an ancestral stock whose habitat is the human body itself. It is not on bad air or foul drains that the attention of the physician will primarily be fixed, but upon disease germs which no bad air or foul drains can create, but which may be pushed by foul air into virulent energy of reproduction. You may think I am treading on dangerous ground, that I am putting forth views that may interfere with salutary practice. No such thing. If you wish to learn the impotence of medical science and practice in dealing with contagious diseases, you have only to refer to a recent Harveian oration by Dr. Gull. Such diseases defy the physician. They must burn themselves out. And indeed this, though I do not specially insist upon it, would favour the idea of their vital origin. For if the seeds of contagious disease be themselves living things, it will be difficult to destroy either them or their progeny without involving their living habitat in the same destruction.

And I would also ask you to be cautious in accepting the statement which has been so often made, and which is sure to be repeated, that I am quitting my own *métier* when I speak of these things. I am not dealing with professional questions. I am writing no prescription, nor should I venture to draw any conclusion from the condition of your pulse and tongue. I am dealing with a question on which minds accustomed to weigh the value of experimental evidence are alone competent to decide, and regarding which, in its present condition, minds so trained are as capable of forming an opinion as on the phenomena of magnetism and radiant heat. I cannot better conclude this portion of my story than by reading to you an extract from a letter addressed to me some time ago by Dr. William Budd, of Clifton, to whose insight and energy the town of Bristol owes so much in the way of sanitary improvement.

"As to the germ theory itself," writes Dr. Budd, "that is a matter on which I have long since made up my mind. From the day when I first began to think of these subjects, I have never had a doubt that the specific cause of contagious fevers must be living organisms.

"It is impossible, in fact, to make any statement bearing upon the essence or distinctive characters of these fevers, without using terms which are of all others *the most distinctive of life.* Take up the writings of the most violent opponent of the germ theory, and, ten to one, you will find them full of such terms as 'propagation,' 'self-propagation,' 'reproduction,' self-multiplication,' and so on. Try as he may—if he has anything to say of those diseases which is characteristic of them—he cannot evade the use of these terms, or the exact equivalents to them. While perfectly applicable to living things, these terms express qualities which are not only inapplicable to common chemical agents, but, as far as I can see, actually inconceivable of them."

Once, then, established within the body, this evil form of life, if you will allow me to call it so, must run its course. Medicine as yet is powerless to arrest its progress, and the great point to be aimed at is to prevent its access to the body. It was with this thought in my mind that I ventured to recommend, more than a year ago, the use of cotton-wool respirators in infectious places. I would here repeat my belief in their efficacy if properly constructed. But I do not wish to prejudice the use of these respirators in the minds of its opponents by connecting them indissolubly with the germ theory. There are too many trades in England where life is shortened and rendered miserable by the introduction of matters into the lungs which might be kept out of them. Dr. Greenhow has shown the stony grit deposited in the lungs of stone-cutters. The black lungs of colliers is another case in point. In fact, a hundred obvious cases might be cited, and others that are not obvious might be added to them. We should not, for example, think that printing implied labours where the use of cotton-wool respirators might come into play; but I am told that the dust arising from the sorting of the type is very destructive of health. I went some time ago into a manufactory in one of our large towns, where iron vessels are enamelled by coating them with a mineral powder, and subjecting them to a heat sufficient to fuse the powder. The organisation of the establishment was excellent, and one thing only was needed to make it faultless. In a large room a number of women were engaged covering the vessels. The air was laden with the fine dust, and their faces appeared as white and bloodless as the powder with which they worked. By the use of cotton-wool respirators these women might be caused to breathe air more free from suspended matters than that of the open street. Over a year ago, I was written to by a Lancashire seedsman, who stated that during the seed season of each year his men suffered horribly from irritation and fever, so that many of

them left his service. He asked me could I help him, and I gave him my advice. At the conclusion of the season this year he wrote to me that he had simply folded a little cotton-wool in muslin, and tied it in front of the mouth; that he had passed through the season in comfort and without a single complaint from one of his men.

The substance has also been turned to other uses. An invalid tells me that at night he places a little of the wool before his mouth, slightly moistening it to make it adhere; that he has thereby prolonged his sleep, abated the irritation of his throat, and greatly mitigated a hacking cough from which he had long suffered. In fact, there is no doubt that this substance is capable of manifold useful applications. An objection was urged against the use of it: that it became wet and heated by the breath. While I was casting about for a remedy for this, a friend forwarded to me from Newcastle a form of respirator invented by Mr. Carrick, an hotel-keeper at Glasgow, which meets the case effectually, and by a slight modification may be caused to meet it perfectly.

We have thus been led by our first unpractical experiments into a thicket of practical considerations. In taking the next step, a personal peculiarity had some influence upon me. The only kind of fighting in which I take the least delight is the conflict of man with nature. I like to see a man conquer a peak or quench a conflagration. I remember clearly the interest I took twenty years ago in seeing the firemen of Berlin contending for mastery with a fire which had burst somewhere near the Brandenburger Thor; and I have often experienced the same interest in the streets of London. Admiring as I do the energy and bravery of our firemen, and having heard that smoke was a greater enemy to them than flame itself, the desire arose of devising a fireman's respirator. But before I describe what has been done in this direction, let me draw your attention to the means hitherto employed to enable a man to live in dense smoke. Thanks to the courtesy of Capt. Shaw, I am enabled to show you the action of the "smoke-jacket," known abroad as the "Appareil Paulin," from its supposed inventor. The jacket is of pliable cowhide. It has arms and a hood, with eye-glasses. With straps and buckles the jacket is tied round the wrists and waist, and a strap which passes between the legs prevents it from rising. On the left side of the jacket is fixed a screw, to which the ordinary hose of the fire-engine is attached, and through the hose air instead of water is urged into the space between the fireman's body and the jacket. It becomes partially inflated, but no pressure of any amount is attainable, because the air, though somewhat retarded, escapes with tolerable freedom from the wrists and waist. Hence the fireman, when his hose is long enough, can deliberately walk in the densest smoke or foulest air. But you see the use of the smoke-jacket necessitates the presence of several men; it also implies the presence of an engine. A single man could make no use of it, nor indeed, any number of men without a pumping engine. Its uses are thus summed up in a communication addressed to me by Captain Shaw:—

"This smoke-jacket is very useful for extinguishing fires in vaults, stopping conflagrations in the holds of ships, and penetrating wells, quarries, mines, cesspools, &c.—any places, in short, where the air has become unfit for respiration.

"The special advantages of this jacket are its great simplicity, its facility for use, and the rapidity with which it can be carried about and put on; but its drawback is that it requires the use of an engine or air-pump, and consequently is of no service to one man alone. For this latter reason smoke-jackets, although very effective for enabling us to get into convenient places for extinguishing fires, have very rarely proved of any avail for *saving life*."

Now, it is that very want that I thought ought to be supplied by a suitable respirator. Our fire-escapes are each in charge of a single man, and I wished to be able to place it in the power of each of those men to penetrate through the densest smoke into the recesses of a house, and there to rescue those who would otherwise be suffocated or burnt. I thought that cotton-wool, which so effectually arrested dust, might also be influential in arresting smoke. It was tried; but, though found soothing in certain gentle kinds of smoke, it was no match for the pungent fumes of a resinous fire, which we employ in our experiments in the laboratory, and which, I am gratified to learn from Captain Shaw, evolves the most abominable smoke with which he is acquainted. I cast about for an improvement, and in conversing on the subject with my friend Dr. Debus, he suggested the use of glycerine to moisten the wool, and render it more adhesive. In fact, this very substance had been employed by the most distinguished advocate of the doctrine of spontaneous generation, M. Pouchet, for the purpose of catching the atmospheric germs. He spread a film of glycerine on a plate of glass, urged air against the film, and examined the dust which stuck to it. The moistening of the cotton-wool with this substance was a decided improvement; still the respirator only enabled us to remain in dense smoke for three or four minutes, after which the irritation became unendurable. Reflection suggested that in combustion so imperfect as the production of dense smoke implies, there must be numerous hydrocarbons produced, which, being in a state of vapour, would be very imperfectly arrested by the cotton-wool. These in all probability were the cause of the residual irritation; and if these could be removed, a practically perfect respirator might possibly be obtained.

I state the reasoning exactly as it occurred to my mind. Its result will be anticipated by many present. All bodies possess the power of condensing in a greater or less degree gases and vapours upon their surfaces, and when the condensing body is very porous, or in a fine state of division, the force of condensation may produce very remarkable effects. Thus, a clean piece of platinum-foil placed in a mixture of oxygen and hydrogen so squeezes the gases together as to cause them to combine; and if the experiment be made with care, the heat of combination may raise the platinum to bright redness, so as to cause the remainder of the mixture to explode. The promptness of this action is greatly augmented by reducing the platinum to a state of fine division. A pellet of "spongy platinum," for instance, plunged into a mixture of oxygen and hydrogen, causes the gases to explode instantly. In virtue of its extreme porosity, a similar power is possessed by charcoal. It is not strong enough to cause the oxygen and hydrogen to combine like the spongy platinum, but it so squeezes the more condensable vapours, and also acts with such condensing power upon the oxygen of the air, as to bring both within the combining distance, thus enabling the oxygen to attack and destroy the vapours in the pores of the charcoal. In this way effluvia of all kinds may be virtually burnt up; and this is the principle of the excellent charcoal respirators invented by Dr. Stenhouse. Armed with one of these, you may go into the foulest-smelling places without having your nose offended. Some of you will remember Dr. Stenhouse lecturing in this room with a suspicious-looking vessel in front of the table. That vessel contained a decomposing cat. It was covered with a layer of charcoal, and nobody knew until told of it what the vessel contained.

I may be permitted in passing to give my testimony as to the efficacy of these charcoal respirators in providing warm air for the lungs. Not only is the sensible heat of the breath in part absorbed by the charcoal, but the considerable amount of latent heat which accompanies the aqueous vapour from the lungs is rendered free by the condensation of the vapour in the pores of the charcoal. Each particle of charcoal is thus converted into an incipient ember, and warms the air as it passes inwards. This is in entire accordance with the thermometric observations of Dr. Marcet.

But while powerful to arrest vapours, the charcoal res-

pirator is ineffectual as regards smoke. The particles get freely through the respirator. In a series of them tested downstairs, from half a minute to a minute was the limit of endurance. This might be exceeded by Faraday's method of emptying the lungs completely, and then filling them before going into a smoky atmosphere. In fact, each solid smoke particle is itself a bit of charcoal, and carries on it, and in it, its little load of irritating vapour. It is this, far more than the particles of carbon themselves, that produces the irritation. Hence two causes of offence are to be removed: the carbon particles which convey the irritant by adhesion and condensation, and the free vapour which accompanies the particles. The moistened cotton-wool I knew would arrest the first, fragments of charcoal I hoped would stop the second. In the first fireman's respirator, Mr. Carrick's arrangement of two valves, the one for inhalation, the other for exhalation, are preserved. But the portion of it which holds the filtering and absorbent substances is prolonged to a depth of four or five inches. On the partition of wire gauze at the bottom of the space which fronts the mouth is placed a layer of cotton-wool, moistened with glycerine; then a thin layer of dry wool; then a layer of charcoal fragments; a second thin layer of dry cotton-wool, succeeded by a layer of fragments of caustic lime. The succession of the layers may be changed without prejudice to the action. A wire-gauze cover keeps the substances from falling out of the respirator. In the densest smoke that we have hitherto employed, the layer of lime has not been found necessary; in a flaming building, indeed, the mixture of air with the smoke never permits the carbonic acid to become so dense as to be irrespirable; but in a place where the gas is present in undue quantity, the fragments of lime would materially mitigate its action.

In a small cellar-like chamber downstairs, with a stone flooring and stone walls, the first experiments were made. We placed there furnaces containing resinous pine-wood, lighted the wood, and placing over it a lid which prevented too brisk a circulation of the air, generated dense volumes of smoke. With our eyes protected by suitable glasses, my assistant and I have remained in this room for half-an-hour and more, when the smoke was so dense and pungent that a single inhalation through the undefended mouth would be perfectly unendurable: and we might have prolonged our stay for hours. Having thus far perfected the instrument, I wrote to Captain Shaw, the chief officer of the Metropolitan Fire Brigade, asking him whether such a respirator would be of use to him. His reply was prompt; it would be most valuable. He had, however, made himself acquainted with every contrivance of the kind in this and other countries, and had found none of them of any practical use. He offered to come and test it here, or to place a room at my disposal in the City. At my request he came here, accompanied by three of his men. Our small room was filled with smoke to their entire satisfaction. The three men went successively into it, and remained there as long as Captain Shaw wished them. On coming out they said that they had not suffered the slightest inconvenience; that they could have remained all day in the smoke. Captain Shaw then tested the instrument with the same result. From that hour the greatest interest has been taken in the perfecting of the instrment by Captain Shaw himself. He has attached to the respirator suitable hoods. The real problem is practically solved, and I can only say that if a tithe of the zeal, intelligence, and practical skill were bestowed on the cotton-wool respirator that Captain Shaw has devoted to the fireman's respirator the sufferings of many a precious life might be spared and its length augmented.*

The discourse was concluded as follows:—"Thus have we been led from the actinic decomposition of vapours through the tails of comets and the blue of the sky to the dust of London, from the germ theory of disease down to this fireman's respirator. Instead of this trivial example, I could, if time permitted, point to others of a more considerable kind in illustration of the tendency of pure science to lead to practical applications. Indeed, those very wanderings of the scientific intellect which at first sight appear utterly unpractical, become in the end the well-springs of practice. Yet I believe there is a philosophy embraced by some of our more ardent thinkers (who I fear on many points commit the well-intentioned, but fatal mistake of putting their own hopeful fancies in the place of fact) that would abolish these wanderings of the intellect and fix it from the outset on practical ends alone. I do not think that that philosophy will ever make itself good in the world, or that any freedom-loving student of nature could or would tolerate its chains."

A short time before the discourse I had an opportunity of inspecting the apparatus of Mr. Sinclair, which has been tested and highly spoken of by the Superintendent of of the Manchester Fire Brigade. The original idea is due to Von Humboldt, who proposed it for the Hartz mines. Galibert constructed the apparatus in an improved form, and it has been still further improved by Mr. Sinclair, who has purchased Galibert's patent. It consists of an air-tight bag, from which issue two tubes that unite on a single one with a respirator mouth-piece. The bag is filled with air, and the wearer inspires through one valve and expires through another. The expired breath is carried to the bottom of the bag, and is stated to remain there in consequence of the chilling experienced in its passage downwards. A bag of not inordinate size is said to be sufficient to supply a man with air for twenty minutes. Mr. Sinclair's apparatus was exhibited during the discourse.

* Mr. Ladd has also proposed a form of mouth-piece which promises well, and Mr. Cottrell has attached to it an ordinary fencing-mask. This will probably be the form of apparatus finally adopted.

ON THE

SPECIFIC GRAVITIES INDICATED BY BAUME'S HYDROMETERS.*

By Dr. WILSON H. PILE, Philadelphia.

IN endeavouring to frame a simple rule or formula by which the degrees of Baumé's hydrometer could be reduced to their corresponding specific gravities, I was led to select the following illustration in determining the relation existing between the two scales, as being thus more readily comprehended than in any other way. Having never met with similar observations by others, I have endeavoured in the following paper to explain, as briefly as possible, the method by which the rules alluded to have been formed.

Without further preamble, and without going into any detail respecting the nature and principles of the hydrometer, which would be foreign to the subject, let a cylindrical tube of thin glass, closed at its lower extremity, be floated in water of the temperature of 60° F., dropping shot or mercury into the tube until it sinks within a short distance of the top; make a line at this point, which call the water-point; now divide the cylinder between this point and the bottom into 145 parts, and number these divisions from the water-line downwards; you will have thus formed a true Baumé's hydrometer for all liquids heavier than water, and, although very unlike the ordinary instrument, yet its indications will be perfectly reliable, provided the tube be of equal diameter throughout.

A question may here arise, why divide the scale into 145 parts? This division was selected as giving a scale corresponding with the average of a number of Baumé's

* From the *Proceedings of the American Pharmaceutical Association*, 1870.

hydrometers from different makers. Baumé himself left no practical or specific directions for this purpose. In fact, an examination of these instruments will, unfortunately, exhibit very wide discrepancies, thus rendering the indications unreliable.

No. I.—FOR LIQUIDS HEAVIER THAN WATER.

		Baumé.	Ratio.	Specific gravity.
Water,	145	0°		
	140	5°	$\frac{145}{140}$	=1·0357
	135	10°	$\frac{145}{135}$	=1·0740
	130	15°	$\frac{145}{130}$	=1·1153
	125	20°	$\frac{145}{125}$	=1·1600
	120	25°	$\frac{145}{120}$	=1·2083
	115	30°	$\frac{145}{115}$	=1·2608
	110	35°	$\frac{145}{110}$	=3·3181
	105	40°	$\frac{145}{105}$	=1·3809
	100	45°	$\frac{145}{100}$	=1·4500
	95	50°	$\frac{145}{95}$	=1·5263
	90	55°	$\frac{145}{90}$	=1·6111

No. II.—FOR LIQUIDS LIGHTER THAN WATER.

	Baumé.	Ratio.	Specific gravity.
210	80°		
205	75°		
200	70°	$\frac{140}{200}$	=0·7000
195	65°	$\frac{140}{195}$	=0·7179
190	60°	$\frac{140}{190}$	=0·7368
185	55°	$\frac{140}{185}$	=0·7567
180	50°	$\frac{140}{180}$	=0·7777
175	45°	$\frac{140}{175}$	=0·8000
170	40°	$\frac{140}{170}$	=0·8235
165	35°	$\frac{140}{165}$	=0·8484
160	30°	$\frac{140}{160}$	=0·8750
155	25°	$\frac{140}{155}$	=0·9032
150	20°	$\frac{140}{150}$	=0·9333
145	15°	$\frac{140}{145}$	=0·9655
140	10°	$\frac{140}{140}$	=1·0000
Water,			
130			
120			
110			
100			
90			

No. I.—FOR LIQUIDS HEAVIER THAN WATER.

	Baumé.	Ratio.	Specific gravity.
85	60°	$\frac{145}{85}$	=1·7058
80	65°	$\frac{145}{80}$	=1·8125
75	70°	$\frac{145}{75}$	=1·9333
70	75°		
65			
60			
55			
50			
45			
40			
35			
30			
25			
20			
15			
10			
5			

RULE.

$$\frac{145}{145 - B.^{\circ}} = \text{sp. gr.}$$

$$145 - \frac{145}{\text{sp. gr.}} = B.$$

No. II.—FOR LIQUIDS LIGHTER THAN WATER.

	Baumé.	Ratio.	Specific gravity.
80			
70			
60			
50			
40			
30			
20			
10			

RULE.

$$\frac{140}{B.^{\circ} + 130} = \text{sp. gr.}$$

$$\frac{140}{\text{sp. gr.}} - 130 = B.$$

To remedy this as far as possible, Mr. Henry Pemberton, of Philadelphia, in 1851, proposed the scale as above described. This was adopted as the standard by the Philadelphia College of Pharmacy the same year, and thus was secured a uniform scale for this instrument.

You will bear in mind that the scale we have just been considering is for liquids that are heavier than water. Now, for liquids lighter than water, it would appear but natural that similar divisions should be continued upwards above the water-line. But it happens, unfortunately, that, from erroneous views taken by Baumé, which need not here be discussed, the degrees for light liquids are larger than those for heavy liquids, and it was found by Mr. Pemberton that an average of several hydrometers showed each degree to be about the $\frac{1}{14}$th part of the scale instead of the $\frac{1}{15}$th. To recur to our cylinder, the space below the water-line must be divided into 140 parts, and then similar divisions carried upwards as far as necessary.

All that part of the scale above the water-line will then indicate the degrees of Baumé for liquids lighter than water.

Another unfortunate idea of Baumé, and one which often leads to error, may here be alluded to. I refer to the numbering of the degrees for light liquids, calling the water-point in this scale 10° instead of 0°, and from thence increasing upwards.

I will remark here, that in the French Codex, published

in 1850, a modified Baumé's scale was ordered to be used, selecting one which would be equivalent to dividing our cylinder into 144 degrees, and retaining the same divisions for liquids lighter than water, but yet continuing the original idea of calling the water-point 10° for liquids lighter than water. Although the instrument, as thus modified, is undoubtedly an improvement over Baumé's scale, yet it does not appear to have been introduced into this country. The scale of this French hydrometer will be found in the appendix to Wood and Bache's "Dispensatory," together with that adopted by the College of Pharmacy of Philadelphia. To proceed with our subject, you will please remember the law of hydrostatics, "that a floating body always displaces a quantity of the liquid in which it floats, equalling in weight the total weight of the floating body itself." If, therefore, our cylinder, while immersed in water, displaces 145 parts, the number of parts which it displaces in any other liquid will necessarily equal the same weight; or, in other words, that number of parts of the liquid will weigh precisely as much as 145 parts of water. The density or specific gravity of the liquid will, of course, be in an inverse ratio to the number of parts displaced, and this relation holds good in whatever number of parts the cylinder is divided, and we have merely to divide the number of parts beneath the surface of the liquid into the number of parts to which it sinks in water to obtain the specific gravity of the liquid.

The diagram which I have here drawn will make this evident. No. I. represents the cylinder, divided into 145 parts for liquids heavier than water; in the adjoining column we see these divisions as numbered in Baumé's hydrometer; the third column gives the ratio which these degrees bear to water; and in the fourth column these fractions are reduced, showing the specific gravity. In the diagram No. II., the cylinder up to the water-line is divided into 140 parts, and then continued upwards as high as required; opposite is the corresponding Baumé's degrees, water being 10, next the ratio, and then the specific gravity.

We are thus enabled to see the relation existing between Baumé's degrees and their specific gravity, and also the rule by which one scale is reduced to the other.

For example, let it be desired to know the specific gravity of the tenth degree of Baumé for heavy liquids; we see by the diagram that this degree is 135 parts from the bottom, and, as has been shown, these 135 parts must equal in weight 145 parts of water, and therefore its specific gravity must be $\frac{145}{135}$ as great, or 1·074. Hence, the directions, subtract the given degree of Baumé from 145, and divide the remainder into 145, the quotient will be the corresponding specific gravity; expressed algebraically, the formula is—

$$\frac{145}{145-\text{B.}^\circ} = \text{sp. gr.}$$

This is for liquids heavier than water; for lighter liquids, a variation of this formula is necessary, on account of the water-point being called 10. The principle is, however, identical in both cases; thus, to ascertain the sp. gr. of 50° Baumé, observe that this degree is but 40° above the water-line, and this, added to the 140 parts below that line, makes 180 parts in all below the fiftieth degree, and this sum divided into 140 will give the required specific gravity, or 0·7777.

The formula for this is—

$$\frac{140}{\text{B.}^\circ - 10 + 140},$$

or, which is the same—

$$\frac{140}{\text{B.}^\circ + 130} = \text{sp. gr.}$$

The converse of these rules, or to ascertain the degree of Baumé corresponding to any given specific gravity, is found by a simple algebraic transfer of terms, and is as follows:—For heavy liquids—

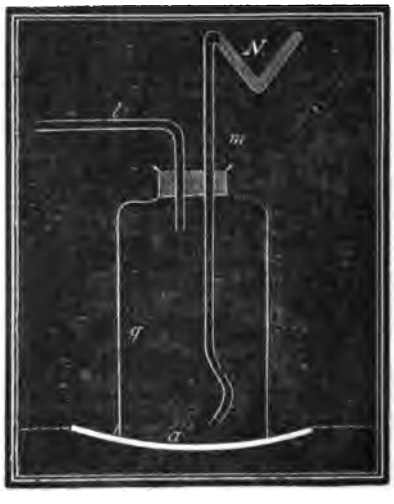
$$145 - \frac{145}{\text{sp. gr.}} = \text{B.},$$

and for light liquids—

$$\frac{140}{\text{sp. gr.}} - 130 = \text{B.}$$

A LECTURE EXPERIMENT.*

In the phenomenon of the spheroidal state, the globule will float when the vapour beneath it is able to support the pressure of the atmosphere plus the weight of the globule. If we remove the former factor, a much smaller vapour tension will be required to produce the phenomenon, as may be proved by the following experiment, described by E. Budde,† in which, with the aid of the air-pump, a Leidenfrost globule is supported upon a metal plate whose temperature is below 100° C. A bell-shaped glass vessel, *g*, is firmly cemented to a copper plate, *a*. Through the



stopper which closed the upper opening pass two glass tubes, *l* and *m*. The first attaches by caoutchouc tubing to the air-pump. The second reaches within the vessel nearly to the plate *a*, while above it is closed and bent into an N form. The bent portion is filled with water. The plate is now placed upon the water-bath, which soon imparts to it a temperature of from 80° to 100° C. The air-pump is now put in operation; the water in N evolves air-bubbles and vapours (gentle heating will facilitate the operation) which mainly accumulate in the upper end of the tube—and force a portion of the water through *m*. The water falls boiling, or very nearly so, upon the plate beneath, the temperature of which is, under the abnormal conditions, considerably above the boiling-point of the water—and all the conditions necessary for the production of the spheroidal state are present. If the rarefaction is carried until the barometer indicates 10 c.m. (about 4 inches) of mercury, and the water-bath is heated to about 90° C., the experiment will succeed without the slightest difficulty, and the spheroids obtained will evince an energetic movement.

The experiment is not a mere physical curiosity, but possesses an importance which our educated readers will doubtless have already appreciated, inasmuch as it is

* From advance-sheets of the *Journal of the Franklin Institute*. Communicated by the Editors.

† *Pogg. Ann.*, vol. ccxviii., p. 158.

decisive in confirming the theory of the spheroidal state. It proves that the force which sustains the globule obeys the laws which govern the tension of vapours.

ON THE

ESTIMATION OF PHOSPHORIC ACID.

By CHARLES E. MUNROE.

(Continued from p. 19).

Disodic Phosphate.—It is quite difficult to obtain this salt anhydrous. It becomes so between 30° and 40°, but as it fuses at 35°, it must be re-pulverised for analysis, and as it is quite hygroscopic, it is liable to change during the operation. A quantity dried over sulphuric acid was used, the phosphoric oxide being determined by ignition.

	Grms.	Grms.	
(1).	1·1130	gave 0·4576	$Na_4P_2O_7$ = 21·98 per cent P_2O_5
(2).	1·2355	,, 0·5075	,, = 21·97 ,, ,,

The mercurous oxide process with cupric oxide gave the following results:—

			Found.	Theory.
(1).	1·0245 grms.	gave 0·5124 grms.	P_2O_5 = 50·01	50·00
(2).	1·2198 ,,	,, 0·4716 ,,	,, = 38·66	21·97
(3).	0·9200 ,,	,, 0·2018 ,,	,, = 21·93	,,
(4).	1·2423 ,,	,, 0·2730 ,,	,, = 21·97	,,

No. 1 was a specimen of anhydrous phosphate. It will be noticed that the second analysis is much too high. In this one the nitro-mercurous phosphate was placed in a mass in the centre of the crucible and completely covered with cupric oxide. When the crucible was heated the cupric phosphate formed coated the outside of the pellet and prevented the further escape of the mercury. This proves the necessity of mixing thoroughly.

Care should be taken that the mercurous nitrate used is not basic. The salt used in this investigation was prepared in the following way. Pure mercury was dissolved, by aid of gentle heat in pure nitric acid in a flat, open vessel. More mercury was now added and the whole boiled until every trace of nitrous acid was driven off. The solution was then allowed to crystallise. To the solution formed from these crystals metallic mercury is added to prevent the formation of mercuric nitrate. By this method the salt is obtained perfectly free from mercuric nitrate and the nitrites.

Ammonio-Sodic Phosphate.—As the ammonia present decomposes the mercurous nitrate, it is well to boil with a little caustic soda until it is driven off. In the first analysis magnesic oxide was substituted for the cupric oxide, but in every other respect the process was the same.

			Found.	Required.
(1).	1·3500 grms.	gave 0·3991 grms.	P_2O_5 = 29·56	29·36
(2).	0·9832 ,,	,, 0·2902 ,,	,, = 29·51	,,
(3).	1·0803 ,,	,, 0·3181 ,,	,, = 29·44	,,

Mean 29·50

Ammonio-Magnesic Phosphate.—The solution was freed from ammonia as in the previous case. By ignition the following results were obtained.

	Grms.	Grms.	
(1).	0·5936	gave 0·3664	$Mg_2P_2O_7$ = 43·00 per cent P_2O_5
(2).	0·6135	,, 0·4123	,, = 42·99 ,, ,,

By the mercurous nitrate process I obtained the following results:—

(1). 1·0785 grms. gave 0·4627 grms. = 42·92 per cent P_2O_5
(2). 0·9500 ,, ,, 0·4084 ,, = 42·98 ,, ,,

Mean 42·95

Calcic Phosphate.—This salt was obtained by precipitating calcic chloride with an excess of disodic phosphate. The precipitate was then carefully washed and dried. This was dissolved in as little nitric acid as possible. If the solution is too acid the precipitate is not formed until sodic hydrate is added. The nitro-mercurous phosphate was ignited with magnesic oxide. By this means the following results were obtained:—

(1). 0·6190 grms. gave 0·1606 grms. P_2O_5 = 25·94 per cent
(2). 0·6765 ,, ,, 0·1755 ,, ,, = 25·96 ,,

Mean 25·95

Mr. Waldo Lincoln employed this process in making an analysis of bone earth, and permits me to cite his results. The nitro-mercurous phosphate was ignited with cupric oxide.

	I.	II.	III.	IV.
Weight taken ..	0·5586	0·4312	0·7025	0·6969
,, SiO_2 found	0·0009	0·0007	—	—
,, P_2O_5 ,,	0·2367	0·1487	0·2421	0·2396
Per cent SiO_2 ..	0·1600	0·1600	—	—
,, P_2O_5 ..	42·3700	34·4800	34·4600	34·3800

Mean of P_2O_5 in three analyses, 34·44

The first analysis presents another instance of failure on account of the precipitate not being properly mixed with the cupric oxide.

Aluminic Phosphate.—This was prepared by adding an excess of disodic phosphate to a solution of potash alum. The precipitate thus obtained was carefully washed and dried. The phosphate was dissolved in the least possible quantity of nitric acid and then treated as in the previous cases. An excess of nitric acid must be carefully avoided. The precipitate was ignited with cupric oxide.

(1). 0·5685 grms. gave 0·1634 grms. P_2O_5 = 28·77 per cent
(2). 0·5827 ,, ,, 0·1672 ,, ,, = 28·69 ,,
(3). 0·6720 ,, ,, 0·1927 ,, ,, = 28·68 ,,

Mean 28·71.

In order to test the process thoroughly it was thought best to determine the composition of this salt and then to compare the found with the calculated percentage. The water was estimated by simple ignition.

(1). 0·8689 grms. gave 0·2624 grms. H_2O = 30·18 per cent
(2). 0·8370 ,, ,, 0·2525 ,, ,, = 30·17 per cent

The aluminic oxide was taken by difference, yielding 41·12 per cent. These results lead to the formula

$$(Al_2O_3)_2(P_2O_5)+8H_2O$$
or $$Al_2O_3+Al_2P_2O_8+8H_2O$$

showing it to be a basic aluminic phosphate.

	Calc. per cents.	Found per cents.
P_2O_5	28·86	28·71
H_2O	29·27	30·17
Al_2O_3	41·87	41·12

I attempted to determine ferric and uranic phosphates in the same way, but on the addition of the sodic hydrate the metallic oxides were precipitated, rendering this method worthless for them. The iron solution was then very largely diluted and precipitated without the addition of sodic hydrate, but all of the phosphoric acid could not be thrown down. Next the ferric was reduced to the ferrous salt by the addition of metallic iron, by passing a stream of sulphydric acid through the solution, and by the addition of sulphurous acid, but without better results. The phosphate was dissolved in potassic cyanide and the ammonio-magnesian solution added to precipitate the phosphoric acid. I hoped that potassic ferrocyanide would be formed which would remain in solution and allow the phosphoric acid to combine with the potassium. The experiment, however, proved unsuccessful, and with these results the further investigation of ferric phosphate was suspended.

Although the ignition with cupric oxide leaves nothing to be desired in point of accuracy, and is a much quicker method than any now in use, yet it was thought that some other agent might be employed which would hasten the process still more.

Stannic oxide was tried for this purpose. To a weighed quantity of pure tin* the nitro-mercurous phosphate was added, then sufficient nitric acid, sp. gr. 1·170, was poured upon the mass to oxidise the tin completely. The whole was evaporated to dryness on a radiator, ignited and weighed. The plan seemed very promising, but the results, from some unknown cause, were far from being satisfactory.

Another idea was to fuse the nitro-mercurous phosphate with some substance which had a low fusing-point, so that the mercury might be volatilised, the phosphoric oxide remaining. Accordingly it was fused with free sulphur, but some of the phosphoric oxide was always volatilised. Potassic dichromate and plumbic chromate were both subjected to trial, but as the results were very unsatisfactory, further investigation in this direction was abandoned.

These results prove conclusively the value of this process for the estimation of phosphoric acid in all cases except those of ferric† and uranic phosphates.—*American Journal of Science.*

CORRESPONDENCE.

THE AMMONIA PROCESS.

To the Editor of the Chemical News.

SIR,—Will you allow me to call attention to the letter of Mr. Dugald Campbell, which appeared in the CHEMICAL NEWS of last week; and especially to the details, as far as they are given, of the experiment brought forward as a sample of many others.

Mr. Campbell took albumen, equivalent to 0·0014 grain or 0·0000909 grm. (9-100ths of a milligrm.) of dry albumen, and distilled from a litre of water. Now, as a matter of practical experiment, Messrs. Wanklyn, &c., state ("Water Analysis," p. 69) that 100 parts of dry albumen yield 10 parts of ammonia on distillation with potassic hydrate and potassic permanganate; consequently, from 9-100ths of a milligrm. of dry albumen Mr. Campbell might expect to obtain 9-1000ths of a milligrm. of ammonia. This struck me as an excessively small quantity, and, on hunting up the delicacy of the Nessler test, I find that Messrs. Wanklyn, &c. (who may fairly be supposed not to underestimate its delicacy), state ("Water Analysis," p. 45) that 1-200th of a milligrm. of ammonia in 100 c.c. of water, or 1-100th in 200 c.c., is the limit of accuracy to be relied on for quantitative work.

To distil off the whole of the ammonia from the albumen taken in the above experiment at least 200 c.c., or, better, 300 c.c., must be driven over. The least quantity of ammonia estimable in this distillate would be therefore 1-100th of a milligrm., so that Mr. Campbell took a trace of albumen which would yield him a quantity of ammonia—9-1000ths of a milligrm.—rather less than *the least quantity*—1-100th of a milligrm.—*that can be fairly estimated by the Nessler test in 200 c.c. of water*, and accordingly found in his distillate only a trace of colour on the addition of the Nessler reagent.

It seems to me that the above experiment of Mr. Campbell proves, in a most striking manner, the accuracy and delicacy of the method under discussion, since it has yielded, in Mr. Campbell's own hands, results slightly more delicate and accurate than those obtained by its authors.

Two rather important data are not given by Mr. Campbell. (1). He does not state whether the water he used was freed from ammonia, &c., before adding the albumen, and consequently leaves the question, as to whether ammonia was or was not obtained on boiling the albumen with sodic carbonate, unanswered. (2). He does not give the quantity distilled over after adding the potassic permanganate, &c.; at least 200 c.c. should have been distilled under the circumstances.—I am, &c.,

SCRUTATOR.

July 18, 1871.

THE AMMONIA PROCESS.

To the Editor of the Chemical News.

SIR,—Mr. Campbell's statement, that a dilute solution of albumen yields its nitrogen in the form of ammonia when it is boiled with carbonate of soda, is an error. In reference to the experiment which Mr. Campbell brings forward, it is sufficient to remark that the total ammonia obtainable by our process from the white of egg taken by him did not exceed the 1-100th of a milligramme.—We are, &c.,

J. ALFRED WANKLYN.
ERNEST T. CHAPMAN.

London, July 17, 1871.

CORRELATION OF ELECTRICAL AND CHEMICAL FORCE.

To the Editor of the Chemical News.

SIR,—Will you allow me, through the medium of your journal, to call the attention of chemists to one or two facts which seem to have been elicited in some experiments which I have been recently trying.

1. In a compound galvanic circuit, I have found that considerably more zinc is consumed in an electrolyte of chloride of sodium than in one of nitrate of soda and other electrolytes. Believing, as a general rule, in the law of changes in the same circuit in exact proportion to the chemical equivalents, I attributed this to a greater local action in chloride of sodium than in nitrate of soda. But in placing zinc for some days in solutions of nitrate of soda and of chloride of sodium, I found no appreciable

* Chemically pure tin can be obtained in considerable quantities and with very little trouble, in the following manner. Ammonio-stannic chloride is first produced by adding to one molecule of stannic chloride, two of sal-ammoniac. Dissolve in the least possible quantity of water and add an excess of chlorhydric acid, which causes the double chloride to crystallise out immediately. Purify completely by re-crystallisation from acid solutions. Dry the salt at 120°. Then fuse with an equal weight of a mixture of one part of potassic cyanide and one of potassic carbonate in a porcelain crucible. On cooling, a button of chemically pure tin will be found.

† Rose proposes in the case of ferric phosphate, to fuse the mercurous phosphate obtained with the mixed carbonates; then dissolve in dilute chlorhydric acid, and precipitate with the ammonio-magnesian solution. This will not effect a complete separation.

Otto's process of precipitating the phosphoric acid as ammonio-magnesic phosphate in the presence of tartaric acid was modified and tested as follows:—Ferric phosphate was prepared by precipitating ferric chloride with disodic phosphate. The precipitate was thoroughly washed by decantation and then evaporated to dryness. By this means the phosphate was obtained as a light yellow powder. A weighed quantity of this was dissolved in dilute chlorhydric acid, sufficient tartaric acid added to keep the whole of the iron in solution, next ammonia in excess, the solution was then heated till it boiled briskly, and the ammonio-magnesian solution was added. The precipitate was ignited and weighed as magnesic pyrophosphate. This method gave the following results;—

(1). 0·6084 grms. gave 0·3437 grms. $Mg_2P_2O_7$=36·13 per cent P_2O_5
(2). 0·7411 „ „ 0·4173 „ „ =36·02 „ „
(3). 1·0294 „ „ 0·5805 „ „ =36·11 „ „
Mean 36·09.

I would call especial attention to the fact, as it shortens the process considerably, that the phosphate solution was boiling when the ammonia-magnesian solution was added. Dr. Gibbs found that when the ammonio-magnesic and ammonio-manganic phosphates were precipitated from boiling solutions, that on cooling they came down as beautiful, highly crystalline precipitates, which, instead of requiring twenty-four hours for precipitation, were ready to be filtered within an hour. This method has been in use in this laboratory for the past six months, and has met with uniform success. It applies as well to the estimation of phosphoric acid as to that of magnesium and manganese.

With this additional treatment for the separation of iron, it is believed that this process will apply to the majority of cases met with in practice.

waste in either. I am aware there have been many facts which have seemed to militate against the law of change according to definite chemical equivalents; and, in this case, the difference of zinc consumed was so great as to suggest the idea that as zinc and chlorine produce much less heat in their combination than zinc and oxygen, and, consequently, I presume, less electricity, it might be possible that such equivalents might be consumed as would produce an equal amount of heat. The facts were not inconsistent with this supposition. But there are so many sources of error in these experiments, that I only wish to draw the attention to the subject of such chemists as have an opportunity of experimenting with greater accuracy than myself.

2. Though zinc is soluble in alkalies, I was surprised to find that zinc and carbon, in an electrolyte of caustic soda, or its carbonates, produce scarcely any action whatever, and what little they do produce very soon ceases altogether. In acids, or ordinary neutral salts, of course the action is very powerful, till weakened by polarisation. —I am, &c.,

H. HIGHTON.

2, The Cedars, Putney,
July 15, 1871.

ESTIMATION OF PHOSPHORIC ACID.

To the Editor of the Chemical News.

SIR,—In Mr. Munroe's paper on the above subject (CHEMICAL NEWS, vol. xxiv., p. 18) the percentage of Al_2O_3 in "pure aluminic sulphate, $Al_2(SO_4)_3.18H_2O$," obtained by that gentleman is 17·88 per cent; the percentage of P_2O_5 obtained in "ammonio-sodic phosphate, $Na(NH_4)HPO_4.4H_2O$," is 29·36 per cent. As my calculations from these formulæ give very different results to the above, may I ask Mr. Munroe to explain the difference between his results and the theory.—I am, &c.,

B. J. GROSJEAN.

MISCELLANEOUS.

Quality of the Gas Supplied to the Metropolis.—Dr. Letheby, the Chief Gas Examiner appointed by the Board of Trade, has recently submitted to the Corporation of London and Metropolitan Board of Works his quarterly report of the gas supplied to London by the Chartered, the Imperial, and the South Metropolitan Gas Companies, from which it appears that the average illuminating power of the gas at the different testing stations has been as follows:—Chartered Gas, at Cannon Street, 17·70 sperm candles; at Gray's-Inn Road, 17·41 candles; at Friendly Place, Mile End, 17·56 candles; at Arundell Street, Haymarket, 17·49. Imperial Gas, at Oakley Square, 15·72; at Camden Street, 15·47; at Graham Street, 16·68. South Metropolitan, at Hill Street, Peckham, 15·88 candles. As regards the illuminating power of the Cannel gas it was equal to an average of 25·48 candles at Cannon Street, and 24·81 candles at Arundell Street. The gas of all the companies at all the testing places has been constantly free from excess of ammonia and from sulphuretted hydrogen, but the amount of sulphur in the gas has fluctuated to a large extent, as from an average of only 12·58 grains per 100 cubic feet of the Cannel gas of the Chartered Company at Cannon Street, to 40·73 grains per 100 feet of the common gas at Gray's-Inn Road. The average proportions of sulphur in the gas at the several testing places have been as follows:—Cannel gas of the Chartered Company, at Cannon Street, 12·58 grains per 100 cubic feet; at Arundell Street, 26·71 grains. Common gas of the Chartered Company, at Friendly Place, 22·47 grains; at Cannon Street, 28·32 grains; at Arundell Street, 30·66 grains; at Gray's-Inn Road, 40·73 grains. Imperial gas, at Camden Street, 25·02 grains; at Graham Street, 27·90 grains; at Oakley Square, 34·28 grains. South Metropolitan gas, at Hill Street, Peckham, 29·26 grains. Dr. Letheby reports that the most notable feature in the quality of the Chartered gas supplied during the quarter has been the excessively large proportion of sulphur, as compared with that contained in the gas at several of the testing places in the corresponding quarter of last year; and, as this increase has been coincident with the opening of the new works at Beckton, he thinks that the processes of manufacture and purification are not as perfect in the new works as they might be.

The Phenomena of Vibration.—A simple apparatus for the observance of some beautiful phenomena can be constructed as follows:—A disk of white cardboard, with apertures oblong in radial direction, is set on a spindle, so as to be rotated at any requisite speed. To examine, for instance, the flame of a gas light (in a glass tube, to prevent disturbance by air currents), place the disk in front of the light, so that the eye can see the light through each slit as it comes to a vertical position. If the speed of the disk's rotation is such that the interval of time between two slits passing the eye is just equal to the period of a vibration of the flame, the flame appears to be motionless; but if the velocity be reduced, the flame is seen to go slowly through its changes of form. If the interval be equal to, or one-half of, or one-third of the period of the vibration of the light, the illusory appearance of a disk having as many, or twice, or three times the number of slits really in the disk is seen. This phantom disk will appear to be motionless when the periods coincide; but when otherwise, it revolves in one direction or the other. It is obvious that the vibrations of the flame can be easily counted by this means. The inventor, Mr. Charles J. Watson, counted, with a sixteen inch tube, 453 vibrations of the flame per second. By this instrument, the undulation of the vibrations of a wire can be seen to travel up and down the wire; and if watched by both eyes through the slits, the spiral course of the undulations can be observed.—*Scientific American.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 11 1871.

This number contains the following original papers and memoirs:—

Hydrated Carbonate of Lime.—C. Rammelsberg.—The author's attention having been accidentally called to some very small crystals adhering to a conferva (a water plant) in a pond, he examined these crystals, and found them to consist of hydrated carbonate of lime, containing 5 molecules of water. This compound was first observed by Pelouze, in a solution of lime in sugar water. This hydrate is characterised by the property of losing its water of hydration at a temperature above 15°, even when it is kept under water.

Camphoric Acid.—F. Wreden.—The first portion of this paper is devoted to the record of the labours of other chemists on this subject, among them R. Brandes (who, as far back as 1823, described the compound of camphor with nitric acid), J. von Liebig, Kachler, and others. The author next describes his process for making camphoric acid, which essentially consists in treating camphor with nitric acid (1·27 sp. gr.) in a large glass flask fitted in the neck with a glass tube which reaches to the bottom of the flask, but is somewhat drawn out, while it is hermetically fastened in the neck by means of gypsum, the open end of the tube being bent, so as to communicate with a flue. The flask is heated for fifty hours in a water-bath; by this mode of preparation a larger quantity of camphoric acid is obtained, the nitric acid is more completely utilised, and the operator is not incommoded by the nitrous fumes.

Regularity of the Atomic Weights.—M. Zængerle.—The value of this excellent memoir depends chiefly on the contents of the tabulated form annexed to it, and far too lengthy to be here reproduced.

On Aurine.—R. S. Dale and C. Schorlemmer.—The substance first obtained in 1861 by Kolbe and Schmitt, by heating phenol along with oxalic and sulphuric acids, has, as is well known, become an article which is regularly prepared in this country on the large scale, and is sold under the name of aurine or yellow coralline. The authors, having investigated this substance, state that the article alluded to is a mixture of different substances. The colouring matter in a pure state is obtained by the action of strong acetic acid, either in the form of chrome-red brilliant diamond-like needles, or in the shape of very small acicular crystals exhibiting a deep red colour with a steel-blue hue; these contain water of crystallisation, which is driven off at 160°, the substance thereby assuming a deep greenish metallic hue. The formula of the anhydrous combination is $C_{38}H_{18}O_6$, that of the red crystals $C_{38}H_{18}O_6+2H_2O$, and that of the steel-blue crystals $C_{38}H_{18}O_6+2\frac{1}{2}H_2O$. By reducing agents, a colourless compound is obtained, which crystallises from an acetic acid solution in prismatic, transparent, yellow-coloured crystals, not containing any water; the formula of this body is $C_{38}H_{20}O_6$. The authors are engaged with other experiments on this subject.

Two Modifications of Benzo-Phenon.—Th. Zincke.—The contents of this lengthy paper record the author's experiments, made with the view to ascertain whether a substance obtained by him from diphenyl-methan is, or is not, a benzo-phenon. The result is that there exist two modifications of this body, both boiling at 300°—one of them crystallising in rhombic-shaped crystals fusing at 49°, the other belonging to the monoklinic crystal system, and fusing at 26°.

Action of Sodium Amalgam upon Oxalic Ether.—A. Eghis.—This paper contains chiefly the detailed description of a series of experiments made by the author in order to verify his former researches on this subject, which had led him to the conclusion that, by the action of sodium amalgam, there is formed glycolic acid, whereas S. Friedländer states that this is an error, and should be glycolinic acid. The author of this paper has, therefore, made a series of comparative investigations, the result of which is decidedly that glycolic acid is the result of the reaction alluded to. The formula of the calcium salt of this acid is $C_2H_2CaO_3+2H_2O$; this salt forms, with chloride of calcium, a double salt, $C_2H_2CaO_3+CaCl_4+3H_2O$, crystallising in octahedra.

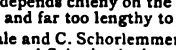
Solubility of Sulphide of Carbon in Alcohol.—The text books on chemistry state that sulphide of carbon is soluble in (miscible with) alcohol in every proportion. This assertion is not, according to the authors, correct, since a point of saturation is reached which depends entirely upon the quantity of water contained in the alcohol. The authors describe in this paper a series of experiments on this subject, made also with the view of applying the degree of solubility of sulphide of carbon in alcohol to the determination of the strength of the latter fluid, it having been found that sulphide of carbon is only miscible in all proportions with perfectly anhydrous alcohol. The temperature, moreover, plays an important part in this matter, since below 15° the solubility of sulphide of carbon in alcohol is greatly decreased. From the extensive details quoted in this paper we give the following instances:—Temperature, 17°; quantity of alcohol employed, 10 c.c.; percentage, by weight, of alcohol, 98·5, dissolved 18·2 c.c. of sulphide of carbon; alcohol at 93·54 per cent dissolved 7·0 c.c. sulphide; alcohol at 84·12 dissolved 3·0 c.c.; alcohol at 48·40 dissolved 0·20 c.c.; alcohol at 47·9 dissolved 0·0 c.c. This paper further contains a series of algebraic formulæ by the aid of which the strength of alcohol may be calculated from experiments made in regard to its behaviour with sulphide of carbon.

Evolution of Heat by Neutralisation of Acids with Bases.—J. Thomsen.

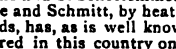
Incorrectness of the Thermo-Chemical Researches made by Favre and Silbermann with the Mercurial Calorimeter.—J. Thomsen.

Some Observations and Critical Remarks.—J. Thomsen.

Researches on the Ether Derivatives of the Polyatomic Alcohols and Acids.—(Seventh part.)—L. Henry.—This portion of the monograph treats on the monochlorides of the biatomic and bibasic acids, and is divided into the following sections:—Oxalic ether-chloride—



succinic ether chloride—



oxamin-acid-ethyl; phenyl-oxamin-acid-ethyl; action of urea upon chloro-carbonic ether.

Propylen Compounds.—L. Henry.—This paper, as also the preceding one, is so filled with lengthy and complex formulæ, essentially required for the proper elucidation of the contents, that any useful abstraction is impossible.

Primary and Secondary Phosphine of the Methyl Series.—Dr. A. W. Hofmann.—In the lengthy introduction to this essay, the eminent author describes in detail the mode of preparation and purification of the phosphines of the methyl series. Methyl-phosphine—

$$CH_3P=\left\{\begin{matrix}CH_3\\H\\H\end{matrix}\right\}P,$$

is a colourless, transparent, very nasty smelling, non-permanent gas, which, by strong pressure, as well as by cold, becomes a colourless fluid, lighter than water, and boiling at −14°. The gas is insoluble in water, and nearly so in ether, but readily soluble in alcohol; it has a very great affinity for oxygen, and ignites spontaneously at a gentle elevation of temperature. Methyl-phosphine forms, with acids, salts, which are all decomposed by water, and have the property of bleaching vegetable colours as chlorine does. Two of these salts, the chlorhydrate and iodhydrate, are described at length as regards their preparation and properties. Dimethyl-phosphine—

$$C_2H_7P=\left\{\begin{matrix}CH_3\\CH_3\\H\end{matrix}\right\}P,$$

is a colourless fluid, lighter than, and insoluble in, water; it boils at 25°, and is an exceedingly oxidisable body which, in contact with air, bursts violently into flame. This base also combines with acids, forming very readily salts soluble in water. Dimethyl-phosphine also combines with sulphur and sulphide of carbon. The author states that he intends to continue the researches on this subject next winter.

Azo-Compounds of Resorcin.—P. Weselsky.—Although the author states that this lengthy paper is only to be considered as a preliminary notice, we can only quote the headings of the sections into which it is divided, for the reason that the paper would require, for its proper understanding, the reproduction of very lengthy and complex formulæ. The author states that very many of the compounds he has discovered are dyes *par excellence*, and will, no doubt, at some future day, be prepared industrially on the large scale. The titles of the sections alluded to are—Diazo-resorcin, $C_{12}H_{12}N_2O_6$; diazo-resorufin, $C_{36}H_{18}N_4O_9$; salts of this base; tetra-azo compounds; nitric acid tetra-azo-resorcin, $[C_{12}H_8N_4O_6+3NO_3]$; nitric acid tetra-azorufin, $[C_{36}H_8N_8O_9+6NO_3]+6NO_3$; salts of this base; mono-nitro-resorcin.

Annalen der Chemie und Pharmacie, June, 1871.

This number contains the following original papers and memoirs:—

On Acridine.—C. Græbe and H. Caro.—The substance just named is obtained from crude anthracen, by treating that material with dilute sulphuric acid, and precipitation of this solution with bichromate of potassa. The dirty brown-coloured precipitate which ensues is repeatedly treated with boiling-water. From the cooled liquid, orange-yellow coloured crystals of chromate of acridine are deposited. These crystals, having been well washed, are next treated with ammonia, and the base thus set free is washed with cold water, and thus freed from chromate of ammonia. When quite pure, acridine is a colourless crystalline body; fuses at 107°; boils, without decomposition, at 360°; is very difficultly soluble in boiling water, and not at all in cold; readily soluble in alcohol, ether, sulphide of carbon, and hydrocarbons; its dilute solutions exhibit, in reflected light, a beautifully blue colour. Solutions of acridine (this name is given by the authors to this substanee, owing to its corrosive biting action upon the skin of the hands and mucous membranes) exhibit, when tested with red-coloured litmus paper, distinctly an alkaline reaction. The formula of acridine is $C_{13}H_{11}N_2$, but the authors state that ulterior researches will be required to prove the correctness (in a structural and constitutional sense) of this composition. The main portion of this exhaustive monograph is further devoted to the following subjects:—Description of the salts of acridine; iodethyl combinations of acridine; nitro-derivatives of acridine; hydro-acridine, $C_{26}H_{20}N_2$; insoluble hydro-acridine.

Eugenol and Methoxybenzoic Acid.—C. Græbe and E. Borgmann.—The contents of this paper mainly record the result of the authors' experiments on the action of a mixture of bichromate of potassa and glacial acetic acid upon euginol-methyl-ether, the result being the formation of bimethoxybenzoic acid, just as happens with cresol-methyl-ether. The bimethoxybenzoic acid, $C_9H_{10}O_4$, is, in some respects, akin to anisic acid, is difficultly soluble in cold, but more readily so in boiling water, forms needle-shaped crystals, dissolves readily in alcohol and ether, and fuses at 180°. The formula of euginol is—

$$C_6H_3\left\{\begin{matrix}OH\\OCH_3\\C_3H_5\end{matrix}\right.;$$

the direct oxidation of this body to an acid did not succeed.

On Pyren.—C. Græbe.—This monograph contains the following sections:—Preparation of pyren. Composition of pyren; formula, $C_{16}H_{10}$. (The reader is also referred to CHEMICAL NEWS, vol. xxii., p. 192, where a brief abstract of a paper on this subject, by the same author, is given.) Pyren exhibits, in pure state, large rhombic-shaped crystals; fuses at 142°; boils at 360°, without decomposition; is difficultly soluble in cold alcohol, but more readily so in that liquid when boiling; and easily soluble in benzol and sulphide of carbon. Pyren is characterised by its behaviour with picric acid, forming therewith a compound, $C_8H_{10}+C_6H_3(NO_2)_3OH$. Nitro-derivatives of pyren; brom-derivatives; pyren-chinon, $C_{16}H_8(O_2)''$; pyren-hydride; pyren-hexahydride, $C_{16}H_{16}$; constitution of pyren.

On Chrysen.—C. Liebermann.—The author opens this lengthy memoir with a review of the labours of Laurent, Williams, Galletly, Vogel, and many other chemists on this subject, and next describes, at great length, the very laborious task of obtaining chrysen, in pure state, from coal-tar. When quite pure, chrysen is a colourless body, fusing at about 250°; it boils at a temperature higher than the boiling-point of mercury; formula, $C_{18}H_{12}$. This memoir contains, further, the following sections;—Mono-nitro-chrysen; tetra-nitro-chrysen;

brom-chrysen; chryso-chinon; chryso-hydro-chinon; dichlor-chryso-chinon and decachlor-chrysen; tetra-nitro-chryso-chinon.

Behaviour of Arsenic Acid with Hydrochloric Acid.—J. Mayrhofer.—This paper contains the record of the results of some experiments made with the view to ascertain under what conditions and in what state of combination arsenic is carried over by the distillation of hydrochloric acid which is contaminated with arsenic. It appears that the degree of concentration of the last-named acid, and the relative proportion of arsenic acid present, and also the care taken in cautiously distilling, are of influence in obtaining an arsenic-free distillate; but, moreover, the treatment of the hydrochloric acid with some chlorine, or, better still, sulphuretted hydrogen, previous to distillation, to be next carefully conducted, will ensure the distillate being free from arsenic.

Decomposition of Chloride of Phosphorus by Water.—K. Kraut.—It appears that, when chloride of phosphorus is poured into ice-cold water, it may be mixed therewith, forming a clear, or, at least, barely turbid liquid, from which phosphorus only separates after some days; but, if the same experiment be made with boiling water, there ensues a violent action, attended with combustion and the separation of a large quantity of amorphous phosphorus. With tepid water, the action is less violent, but the effect similar, and the same again happens when an excess of the chloride is treated with a small quantity of water.

Fourteenth Treatise on the Determination of the Chemical Position of some of the Toluol Derivatives.—F. Beilstein and A. Kuhlberg.—This portion of this very exhaustive monograph contains the following chapters:—Derivatives obtained by starting from dinitro-toluol; derivatives of para-toluidine; derivatives of meta-toluidine; derivatives of ortho-toluidine; isomeric toluylen-diamines.

Carnin, a new Base met with in Extract of Meat.—Dr. H. Weidel.—This treatise contains the record of the author's experiments made with large quantities of extract of meat with which Prof. von Liebig kindly supplied him, the chief result being the discovery of a new organic base, present to about 1 per cent in the extract. The mode of preparing carnin is a tedious and rather complicate process. Carnin is, in pure state, a crystalline solid, insoluble in cold, readily soluble in boiling water, and insoluble in alcohol and ether. Carnin has a bitter taste, a neutral reaction, and is not precipitated by neutral acetate of lead. Formula, $C_7H_8N_4O_2$; being different from the formula of theobromine, $(C_7H_8N_4O_2)$, by only one atom of oxygen. The author describes a series of salts of carnin, and devotes a large portion of his paper to the description of physiological experiments made with this newly-discovered organic base.

Annales de Chimie et de Physique, November, 1870.

This number contains the following original papers:—

Memoir on the Acetic Derivatives of the Carbohydrates—viz., Mannite and some substances isomeric therewith—and of other Immediate Vegetable Principles.—Dr. Schützenberger.—The continuation and end of this lengthy essay.

Inequality of the Loss of Acid and of Salt in the Vicinity of the Poles of a Galvanic Battery.—E. Bourgoin.—The author first gives a review of the labours of Daniell, Miller, Pouillet, Hittorf, Grotthuss, d'Almeida, and others on this subject, and next describes at length a series of experiments, from which the following main results may be deduced:—When the galvanic current passes through acidulated water, it will be seen that, though the total effective work done by each pole is the same, the quantity of acid found in each compartment at the end of the experiment will be found to vary considerably. The three following cases may be distinguished:—(1) The acid is accumulated regularly at the positive pole; this occurs with sulphuric, nitric, phosphoric, benzoic, succinic, camphoric, &c., acids. (2) There is no loss at the positive pole; the loss is only experienced at the negative pole, since half of the electrolysed acid is regenerated in the other compartment. (3) The two compartments become simultaneously poorer; this occurs with lactic, tartaric, citric, and, in general, all the very readily oxidisable acids.

Chemico-Crystallographical Investigations on the Ferrocyanides.—Dr. Wybouroff.—The continuation of an essay commenced in the third series (the present number belongs to the fourth series) of this periodical. This portion is illustrated with a series of engravings, and the contents belong strictly to crystallography.

December, 1870.

The following original memoirs and papers are published in this number:—

Action of the Haloids in Free State, and of some Chlorides, upon Glucose.—A. Colley.—The contents of this lengthy essay describe the action of dry chlorine, bromine, and iodine upon anhydrous glucose, $C_6H_{12}O_6$. The result of the experiments is, that dextrogyrating glucose is a pentatomic compound—that is to say, that it contains five oxyhydryles, (OH), capable of being exchanged for acids, &c.; and, since glucose contains six atoms of oxygen, one of these must be combined in another manner than that of an oxyhydryl; but in what manner is not clearly elucidated by the author, who gives on this point some speculative theories not proved by experiment.

Superficial Tension of Liquids.—E. Duclaux.—A lengthy algebraico-physical essay illustrated with woodcuts exhibiting geometrical figures.

Heat Evolved by the Combustion of Coal.—A. Scheurer-Kestner and C. Meunier.—This extensive monograph, illustrated with woodcuts, is a most valuable specimen of the application of high scientific and practical knowledge, and exceeds any work hitherto done in this direction. This essay is, however, far too lengthy for either useful abstraction or for complete translation.

Journal für Gasbeleuchtung und Wasserversorgung, No. 11, 1871.

This number only contains matter strictly belonging to gas- and water-works' engineering and management.

Bulletin Mensuel de la Société Chimique de Paris, November, 1870.

From the *procès-verbaux* of the meetings of this Society published in this number, we abstract the following matter:—

Acetate of Alumina Useful for the Purpose of Rendering Woven Fabrics Waterproof without thereby Impeding the Passing Off of the Perspiration.—Prof. Balard.—The author prepares the acetate of alumina by dissolving 30 grms. of acetate of lead in ½ a litre of water (best distilled), and also 24 grms. of sulphate of alumina in half a litre of water. These solutions, having been mixed, are next filtered, after which the fabric is immersed therein for a quarter of an hour, and, after having been well drained, is dried in the air.

Substances which yield Nitrate of Potassa.—MM. Thiercelin and Willm.—It should hereby be observed that, at a comparatively remote period, saltpetre was regularly manufactured in most European countries by a process too long to be further alluded to here, and well known, undoubtedly, to most of our readers. The authors state that the richness of the saltpetre-yielding materials recently tested by them varies very much. They found that the efflorescence now and then met with, especially on the walls of old stables, contained as much as 67 per cent of saltpetre; but this material is rare. Old wood-ash yielded ½ per cent; the mortar of a wall covered with ivy yielded 2·6 per cent; and the mortar of the same wall at a spot not covered with that plant, 4·6 per cent of saltpetre.

This number contains, moreover, the following original papers and memoirs:—

Saltpetre Industry in France before the Nineteenth Century.—Dr. Berthelot.—This memoir, a valuable contribution to the history of industrial chemistry, is far too lengthy for any useful abstraction; it contains the following chapters:—History of the saltpetre manufacture in France from the oldest times up to the beginning of this present century; report on saltpetre by the Scientific Committee for the Defence of Paris; nature and richness of the materials capable of yielding saltpetre in Paris; processes to be applied for the collection of these substances; hints for utilising and properly collecting ash and other materials which may yield saltpetre.

Preliminary Notice relating to Etherification.—M. Lorin.—The polyatomic alcohols, properly so-called, decompose, under 100°, oxalic acid into water, carbonic and formic acids, yielding thereby *formine* of the alcohol employed, and aqueous formic acid, containing 56 per cent of formic acid, according to the following formula:—$C_4H_2O_8,4HO = C_2O_4 + C_2H_2O_4,4HO$.

Preliminary Notice on the Formation of the Amides of the Fatty Acids.—M. Lorin.—The decomposition of the tartrates of ammonia, either acid or neutral, yield, at 200°, among their products of decomposition, water, carbonate and acetate of ammonia, and formiamide. The details of these experiments will be published at a future date.

NOTES AND QUERIES.

Kelp Liquors.—(Reply to "Iodine Manufacturer.")—It is not easy to state precisely the cause of the action of kelp liquors upon the iron, since it would be necessary to know all the conditions of the case. It may be, and very probably is, caused by the decomposition of the chloride of magnesium, whereby some hydrochloric acid is set free, which, of course, will attack the iron and blacken the salts; but there may exist other causes, which depend upon conditions, which, without a special investigation, cannot be explained and remedied. It is in this instance, as in many others, "*cessante* (*sublata*) *causâ*, *cessat effectus*."

Temperature of the Sea.—(Reply to "Thermo.")—This subject belongs to physical geography, and we need hardly call your attention to the fact that the temperature, especially at the surface, of the sea must, of necessity, vary, in consequence of a great many causes which influence it, as, for instance, the latitude, shallowness, surrounding coasts, and water discharged from rivers. It is, therefore, clear that no concise answer can be given to your query; but, by consulting either Berghaus's "Physikalischer Atlas," or other works on physical geography, or the article "Sea" in any encyclopœdia, say Chambers's, vol. viii., p. 581, you will there find full information on this subject. The works herein alluded to may be inspected at the library of the Commissioners of Patents.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 609.

NOTES ON THE PRACTICAL PHOTOMETRY OF COAL-GAS.

By Dr. WALLACE,
Gas Examiner for the City of Glasgow.

THE following arrangement of the different parts of the photometric apparatus has been found convenient, and has been so highly approved of by those who have seen it that it is thought worthy of a brief description. The meter is not placed at the end of the photometer bar at which the gas is burned, but towards the candle end, and immediately below that part of the bar where the observations are usually made; and attached to the outlet is a three-way stop-cock with lever handle, the side branch of which is connected by a few inches of pipe with the inlet, so that the gas may be passed through the meter, or direct to the burner, as may be desired, the gas being, in either case, kept constantly burning. At the candle end, and on a level with the photometer bar, is placed a small shelf supporting the candle balance; and this is arranged so that the candles have to be moved only a few inches into the receptacle at the end of the photometer. The gas is now passed through the meter until the hand comes to zero, and the stop-cock is turned so as to pass the gas direct to the jet. The clock, which is either attached to the meter or placed immediately beside it, is also adjusted, and the candles are nearly counterpoised. At the moment when the balance turns, the operator with one hand turns the stop-cock, with the other sets the clock in motion. The candles are now placed in position, and by the end of the first half minute the operator is ready to take the first observation. The sight-box has in front of it stereoscopic lenses, so as to shorten the focus of the eyes, and make the images of the two sides of the disc more distinct, at the same time that they coalesce or overlap one another. By this means great accuracy of observation is attained, and the influence of the different colours of the two flames is entirely removed. Two circular screens of very light wood, 18 inches in diameter, strengthened by cross-bars and having in the centre openings 4 inches square, are fixed on the photometer bar, one on either side of the sight-box and about 20 inches apart, and the sight-box is provided with two side flaps of thick vulcanised india-rubber; the object of these arrangements being to prevent the possibility of any light passing to the eyes of the operator but that reflected by the mirrors in the sight-box. At the end of the tenth minute the stop-cock of the meter is reversed, and, at the same moment, the candles are extinguished; after which the operator leisurely notes the consumption of gas and the loss of weight of the candles. The advantage obtained by this arrangement is that the gas examiner does not require to move from his position opposite the meter during the whole experiment, while the meter is read off only when stationary. The stereoscopic sight-box is not an essential part of the apparatus, and requires great care in the adjustment of the lenses, but when these are carefully fixed the results obtained are highly satisfactory.

In the arrangement above described, the governor is placed immediately to the right hand of the meter (supposing the gas to be burned at the right side of the photometer) and the King's pressure gauge at the left-hand side, so that both are readily observed or corrected. The pressure at which it has been found best to burn the Glasgow gas (28 to 30 candles) is from four to five-tenths, and the standard Cannel batswing supplied by Sugg is employed at all the testing stations. In order to prevent evaporation, the surface of the water in the meters, pressure gauges, and governors, is covered with a layer of about one-sixteenth of an inch of "intermediate" paraffin oil. This oil has a gravity of 850 to 860, and a firing-point of about 250° F., and does not affect the illuminating power of the gas, nor does it thicken by exposure to cold.

In the estimation of the sulphur in coal-gas it is usual to cut off the gas, by means of a pin acting on a lever, at 10 cubic feet, but it is more advantageous to adopt 13·7 cubic feet as the quantity, as in this case the number of grains and fractions of a grain of barium sulphate obtained represents the number of grains of sulphur in 100 cubic feet of the gas. The half of this quantity, or 6·85 cubic feet, may also be taken, but in this case the quantity of barium sulphate must be multiplied by two. The apparatus used in Glasgow is that of Dr. Letheby, with the addition of a second cylinder of about twice the capacity of the first.

The estimation of ammonia is made by means of a very simple apparatus. A tray of copper coated with paraffin, or, still better, one of porcelain, about 12 inches long by 4 wide, and 1 inch deep, has inverted in it a similar vessel 11½ inches long, 3½ inches wide, and nearly the same depth as the tray. At each end of the inverted vessel is a coupling, so that the gas to be used in the sulphur estimation can be passed through this apparatus before going to the burner. Into the tray is placed 100 measures of a test-liquid consisting of dilute sulphuric acid of such strength that this quantity would be exactly neutralised by 13·7 grains of ammonia, and water is added, if necessary, to give a depth of about a quarter of an inch of liquid. 13·7 cubic feet of gas are now passed through the apparatus in the usual manner, after which the contents of the tray are tansferred to a white porcelain basin, and the tray and inverted vessel washed by means of a washing bottle, and the washings added. Some tincture of litmus is now added, and from a burette is dropped, with constant stirring, a solution of caustic potash, 100 divisions of which correspond exactly to 100 divisions of the dilute acid. When the blue colour of the litmus is restored the number of divisions consumed is read off, and the difference between it and 100 divided by 10 gives the number of grains of ammonia in 100 cubic feet of gas. The absorption of the ammonia is so perfect that not a trace can be detected by afterwards passing the gas through the ordinary bulbs filled with beads or broken glass.

ACTION OF HEAT ON PROTOPLASMIC LIFE.

By F. CRACE-CALVERT, F.R.S., &c.

THOSE investigators of germ-life who favour the theory of spontaneous generation have assumed that a temperature of 212° F., or the boiling-point of the fluid which they experimented upon, was sufficient to destroy all protoplasmic life, and that the life they subsequently observed in these fluids was developed from non-living matter.

I therefore made several series of experiments, in the hope that they might throw some light on the subject.

The first series was made with a sugar solution, the second with an infusion of hay, the third with solution of gelatine, and the fourth with water that had been in contact with putrid meat. The hay and putrid-meat solutions were taken because they had often been used by other investigators; sugar was employed, being a well-defined organic compound free from nitrogen, which can easily be obtained in a state of purity; and gelatine was

used as a nitrogenised body which can be obtained pure and is not coagulated by heat.

To carry out the experiments, I prepared a series of small tubes made of very thick and well-annealed glass, each tube about four centimetres in length, and having a bore of five millimetres. The fluid to be operated upon was introduced into them, and left exposed to the atmosphere for sufficient length of time for germ-life to be largely developed. Each tube was then hermetically sealed and wrapped in wire gauze, to prevent any accident to the operator in case of the bursting of any of the tubes. They were then placed in an oil-bath, and gradually heated to the required temperature, at which they were maintained for half an hour.

Sugar Solution.—A solution of sugar was prepared by dissolving 1 part of sugar in 10 parts of water. This solution was made with common water, and exposed all night to the atmosphere, so that life might impregnate it. The fluid was prepared on the 1st of November, 1870, introduced into tubes on the 2nd, and allowed to remain five days. On the 7th of November twelve tubes were kept without being heated, twelve were heated to 200° F., twelve to 300°, and twelve to 400° F.

The contents of the tubes were microscopically examined on the 1st of December, twenty-four days after heating.

Sugar solution not heated.	Heated for half an hour at 212° F.	Heated for half an hour at 300° F.	Heated for half an hour at 400° F.	Heated for half an hour at 500° F.
There were about 30 animalcules under each field of the microscope, principally *small black vibrios*, 2 or 3 microzymes swimming slowly about, 3 or 4 *ordinary swimming vibrios*, and a few Bacteria.	A great portion of the life had disappeared, no animalcules were swimming; still this temperature had not completely destroyed life. 4 to 5 *small black vibrios* were observed moving energetically to and fro; 2 or 3 *ordinary vibrios* were also observed moving energetically in the same position of the field, that is, without swimming about.	The sugar was slightly charred, but the life was not entirely destroyed, as 1 or 2 *ordinary vibrios* and 1 or 2 *small black vibrios* were observed in motion under the field of the microscope.	No fungus matter observed. The fluid was filled with irregular masses of coagulated matter, and life had disappeared.	No life present.

Remarks.—The black vibrios here referred to are far more opaque than the other varieties of vibrios, and are the most important of all, as I have found them to resist not only very high temperatures, but all chemical solutions. I shall, in my paper on putrefaction and the action of antiseptics, describe the various vibrios and give drawings of them.

Hay Infusion.—An infusion of hay was made by macerating it in common water for one hour, then filtering the liquor, and leaving it exposed to the atmosphere all night, when it was sealed in the small tubes, twelve of which were used for each experiment. The infusion was made on the 4th of November, sealed in tubes on the 5th, and heated on the 7th.

The results were examined on the 1st of December, 1870, twenty-four days after being heated.

Hay infusion not heated.	Heated for half an hour at 212° F.	Heated for half an hour at 300° F.	Heated for half an hour at 400° F.	Heated for half an hour at 500° F.
Fungus matter was observed growing on the surface of the fluids in two of the tubes. On subjecting the contents of some of the tubes to examination, from 20 to 25 animalcules were observed under each field of the microscope. This kind of life resembled small dots moving energetically to and fro; 1 or 2 ordinary vibrios were also present.	No fungus matter was noticed on the surface in any of the tubes. A few small black vibrios present in the original solution were also present in this.	No fungus matter present, but some of the small black vibrios were still present, although in less numbers.		

Gelatine Solution.—A solution of gelatine, prepared of such strength that it remained liquid on cooling, was exposed for twenty-four hours to the atmosphere. It was then introduced into the small tubes, and the tubes sealed. The solution was made on the 4th of November, the tubes sealed on the 5th, and subjected to the different temperatures on the 7th.

The fluids were examined on the 1st of December, 1870, twenty-four days after being heated.

Heated for half an hour at 400° F.	Heated for half an hour at 500° F.
The sugar was almost entirely decomposed; no trace of life was observed.	No life observed.

Not heated.	Heated for half an hour at 100° F.	Heated for half an hour at 212° F.	Heated for half an hour at 300° F.	Heated for half an hour at 400° F.	Heated for half an hour at 500° F.
A large quantity of life was present—namely, microzyma and several distinct species of vibrios, among which were a number of the small black ones frequently mentioned.	This temperature had but slightly affected the life present, the animalcules being as numerous as in the liquid not heated, and moving as usual. However, one species of very long vibrios appeared to be considerably affected, as they were much more languid in their movements.	This liquor differed from all the others in being turbid and coagulated. Life was still present; and although heat had deprived the animalcules of the power of locomotion, still they retained a sufficient amount of vital force to place it beyond a doubt that life was not destroyed.	The liquid was quite clear, the albumen (which is coagulated at 200°) appearing to be re-dissolved. A large quantity of the life in the fluid was destroyed, but some vibrios still remained, the small black ones being the most numerous.	All life had disappeared.	All life had disappeared.

Gelatine solution not heated.	Gelatine solution heated for half an hour at 100° F.	Heated for half an hour at 212° F.	Heated for half an hour at 300° F.	Heated for half an hour at 400° F.
There were 7 or 8 animalcules under each field, 5 or 6 of which were quite different to any thing observed in the other fluids. They had long thin bodies, swimming with a peristaltic motion. 1 or 2 ordinary swimming vibrios were also present; but the small black vibrios were absent.	Life seemed to have only slightly decreased, and none of the animalcules were swimming. The peculiar animalcule mentioned in the first column appeared to retain still its peristaltic motion, but not sufficient power to move across the field, a few ordinary vibrios being also observed moving to and fro.	A very decided diminution in the quantity of life present was noticeable.	No life present.	No life present.

Putrid-Meat Fluid.—Water was placed in an open vessel, and a piece of meat suspended in it until it became putrid and contaminated with myriads of animalcules. This fluid was placed in the usual tubes, which were sealed on the 7th of November, and heated on the same day.

The contents of the tubes were subjected to examination on the 1st of December, or twenty-four days after having been heated. (See Table in next column.)

The results recorded in the above Tables show that protoplasmic life is but slightly affected by a temperature of 212° F., and that, even at a temperature of 300° F., it is not entirely destroyed, excepting in the case of gelatine. In all the other fluids a temperature of 400° F. is necessary to completely destroy the life. These experiments, therefore, clearly show that the life found by previous experimenters in fluids which have been submitted to heat was not due to heterogenesis but to life which had remained in the fluids, as I have seen no experiment reported where the temperature to which the fluids were exposed exceeded 300° F.*

I am the more justified in making this statement, as I have repeatedly examined the contents of tubes which had been submitted to a temperature of 400° F., both immediately after cooling and at all periods up to thirty days, and was unable in any instance to detect the slightest trace of life.

This important result corroborates those recorded in my previous paper, and proves that the spontaneous-generation theory is not yet by any means established.

It occurred to me that it might be interesting to examine the influence on pure albumen of the putrid-meat fluids that had been heated, and note whether they still possessed the property of propagating life. A solution was prepared by mixing the albumen of a new-laid egg with pure distilled water free from life (prepared as described in my previous paper). Equal volumes of this solution were placed in six small test-tubes, which had been cleansed with hot vitriol and well washed with pure water. To one tube two drops were added of the putrid-meat solution that had been heated to 100° F., to a second two drops of that heated to 212° F., to a third two drops of that heated to 300° F., to a fourth an equal bulk of fluid heated to 400° F., and to a fifth the same quantity heated to 500° F. In the sixth, the albuminous solution, without anything added, was kept for comparison.

The tubes were sealed, and kept from the 1st of February to the 9th.

* It is with pleasure that I find these experiments to confirm the suggestion of Dr. Beale, in his work entitled "Disease Germs, their Supposed Origin," page 50 (which I read a few weeks ago), that "living forms might live though exposed, under certain conditions, to a temperature of 350° F."

Results of Examination.

Albumen solution.	Albumen solution, with putrid-meat liquor, heated to 100° F.	Albumen solution, with putrid-meat liquor, heated to 212° F.	Albumen solution, with putrid-meat liquor, heated to 300° F.	Albumen solution, with putrid-meat liquor, heated to 400° F.	Albumen solution, with putrid-meat liquor, heated to 500° F.
In each drop 2 or 3 small black vibrios, moving to and fro.	Abundance of life.	Abundance of life.	Much less life than in the two fluids previously examined.	In each drop 2 or 3 small black vibrios, moving to and fro.	In each drop 2 or 3 small black vibrios, moving to and fro.

These results clearly show that, at the temperature of 100°, 212°, and 300° F., life and its germs had not been destroyed, whilst at 400° F. they had; for the results of the examination were in this case exactly identical with those of the albumen solution itself; and the life found was doubtless introduced in the preparation of the solution, and was not due to any life having remained in the fluids that had been heated.

Although perfectly aware of the interesting researches of Professor Melsens, proving that the most intense cold does not destroy the active power of vaccine lymph, still I thought it desirable to ascertain the effect of a temperature of 15° F. on well-developed germ-life, similar to that which had been subjected to the action of heat.

Some putrid-meat liquor, therefore, containing a large quantity of microzyma and vibrios, was subjected for twenty hours to the influence of a temperature ranging between the freezing-point of water and 17° below that point, when the ice was melted and the liquor examined. The animalcules retained their vitality, but appeared very languid, and their power of locomotion was greatly decreased.

Two hours after melting the ice the liquor was again examined, when the animalcules appeared to be as energetic as before.

ON THE ORIGIN OF THE DIAMOND.*

By the Rev. W. B. CLARKE, M.A., F.G.S.

(Continued from p. 18).

Diamonds in Brazil.

Brazil seems naturally to claim our first attention. It has been found that in a certain Brazilian rock called *itacolumite*, diamonds have been found *in situ*, and, therefore, all diamonds are assumed to have been derived in a similar way, wherever a rock imagined to be itacolumite exists.

In 1846, Professor Shepherd, of South Carolina (*A. S. J.*, ii., 253), announced the extensive development of the rock in that State, and he gives a figure and description of a diamond from gold washings in that formation. In Brazil, however, they occur in great numbers, in the lower itacolumite beds. According to Humboldt this rock belongs to the very oldest sedimentary deposits.

So far as my own observation has gone this rock does not occur in New South Wales, and even in Brazil, as I will show, diamonds are not confined to it. My friend Mr. Ulrich, late of the Victorian Survey, says the same of the sister colony, and assures me he had very good opportunities of satisfying himself by examining the Brazilian specimens at the last International Exhibition at Paris. Humboldt (*Essai Gèognostique Paris*, 1820, p. 89), includes itacolumite in the quartz rock series parallel with his primitive clay slate.

Von Cotta places it among the crystalline schists, and describes it as a fine-grained micaceous talcose or chloritic schist, *sometimes* flexible, holding occasional quartz pebbles with magnetic iron and gold, as well as diamond. According to Eschwege, it passes into *itabirite*, which belongs to the red hæmatitic group. Other writers include it with "mica schist," "quartz of the mica slate," and "elastic sandstone." Heusser and Claraz consider it a "granular quartz," sometimes bearing quartz veins with pyrophillite lime. Eschwege says it attains in Brazil a thickness of many thousand feet, ranging for hundreds of miles. The North Carolina species lies between limestone and clay slate. It is said that it occurs in Portugal, Spain, and on the Rhine. But this is doubtful. On the whole, it may be held to be a transmuted sedimentary rock—a friable quartz or sandstone.

M. Damour (*Bull. S. G. de France*, vol. xiii., 2nd series, p. 543), mentions the occurrence in Brazil of diamond bearing sand near Bahia, containing numerous minerals and ores, and states that the diamonds often contain spangles of gold in their cavities. He enumerates thirty-two mineral species, among them very minute rhombohedral dodecahedrons of garnet of a topaz yellow colour; a similar occurrence to that of Two Mile Flat, noticed by Mr. Norman Taylor, where *brown* garnets of the same form occur.

M. Damour suggests, in relation to the statements of M. Favre (referred to above), that the occurrence of the same minerals with diamond in different countries would throw some light on the formation. I may add that this is the principal reason which induces me now to enter so fully into this discussion.

Mr. Taylor instances as many varieties as M. Damour; but the so-called gems in the list given by the latter are confined to quartz, zircon, garnet, and tourmaline; ruby, sapphire, and corundum being absent, and euclase having been since added. The metals seem to predominate.

There is, according to M. Claussen, another solid matrix of diamond in Brazil, which he calls *itacolumite sandstone* (a secondary red sandstone), which overlies the crystalline beds, and once had an enormous development; to its denudation he attributes a considerable portion of the materials forming the mixed erratic diamond-bearing deposits; but in this he finds neither gold nor platinum. M. d'Archiac gives a very clear abstract of Claussen's remarks in his *Progrès de Géologie* (vol. ii., 379—383).

In the province of Matto Grosso, at the waterparting of the basins of the Amazon and Parana Rivers, a little south of 14° S. latitude, and at an elevation of some 1200 feet above the sea, is the diamond field of the Sierra Diamantina.

But the most important field in a geological, if not commercial view, is that which, ranging at a distance fully 900 miles S.E. of the former, stretches through the province of Minas Geraes, between 16° and 26° S. latitude, and even comes down to the coast at San Joao do Barro, where, in 1850, a chance washing of the underlying schist disclosed the presence of many diamonds. The deposit is not confined to the beds of rivers or ravines, but covers the slopes and tops of the hills. This deposit ceases exactly at the boundary of the bituminous beds of the coal measures of St. Catherine.

Is this, then, I would ask, any indication of the origin of diamond in carboniferous rocks? if so, ought not those rocks to contain diamond?

In the north part of Minas Geraes, jurassic calcareous formations cover the red sandstone, and these are, in turn, subordinate to gypseous marls and rock salt. Yet in the ravines, cut down to the sandstone, through the overlying beds, diamonds are found, *i.e.*, *above* the carboniferous formation.

Moreover, in 1839, diamonds were discovered in the psammite of Serro de Santo-Antonio de Grammagoa *imbedded* in the rock, whereas in the preceding itacolumite sandstone they occur between the plates of mica, just as garnets occur in mica-schist. The edges of these are

* From the Anniversary Address delivered to the Royal Society of New South Wales.

rounded, whilst in the psammite the angles are *uninjured*, proving that the transmutation of the sandstone into itacolumite has also affected the diamond crystallisation. For a long period the red psammite and the secondary itacolumite sandstone have been regarded as the sole matrices of diamond, whence it has been derived by the detrital erratic deposits; but since then, it has been found in the true itacolumite subordinate to the talc schists with quartz. The diamonds in the derived deposits are more numerous the nearer deposits are to the solid rocks. The detrital beds are classified according to their character.

Thus *Groupiara* is a drift not due to the present system of drainages. *Burgalho* or *Gurgalhoa* consists of superficial fragments of underlying rock. The decomposed schist of the latter is called *barro*. A sandy mass between these is spoken of as *terra*. Another bed of granular itacolumite is known as *pizarro*; but all belong to the decomposed rocks.

Cascalhao represents the sand, clay, and pebbles in the beds of rivers, torrents, lakes, and of the hollows in their courses through the solid rocks. *Tahoa-canga* or *tapahan-canga* is what we call in Australia *cement*.

The cascalhao of the old watercourses goes by the name of *guipara*; that at the heads of rivers *tabuleira*; and the partly rounded pebbles of the present streams are denominated *corrido*.

The assemblage of all the minerals associated with the diamond is, according to Heusser and Claraz, from whom the last four terms are taken, called "*the formation*."

We learn further from these authors that though diamond belongs undoubtedly in Brazil to itacolumite and metamorphic schist, yet it is not so necessarily; for the itacolumite mountains do not always contain diamond, and in that of Itacolumi itself none are found.

The minerals seem to follow a choice as to their matrix and associations. Thus anatase occurs with suboxide of iron—rutile and brookite. Euclase is found with topaz, in a whitish clay of decomposed rock.

Specular iron ore, rutile, black tourmaline, hyaline, and smoky quartz are associated. Topaz (sometimes "rotten") is abundant, but is no longer, in comparison with euclase, an object of search.

Ores of tellurium, as well as sulphur, occur in some localities. In the crystalline schists crystals of lime, arragonite, magnetic iron pyrites, copper pyrites, manganese ores, and chromate of lead are met with. Scorodite and pseudomorphs of the same also occur in the schists and in the "*tapahan-canga*." Amethyst is found in veins in schists and gneiss, whilst chrysolite, cymophane, and green tourmaline collect in the cascalhao of the crystalline schist rivers.

Mr. Heuland, in 1823, exhibited to the Geological Society of London (*Transactions*, second series, i., p. 119), a diamond in cascalhao surrounded by scorodite (a cupreous arseniate of iron), which I do not see in M. Damour's lists, but which was found by Eschwege; and Dana says it encrusts quartz and beryl, and is found in Victoria with gold and arseno-pyrites. Of the latter mineral Mr. Ulrich gives three localities. It has not yet been found on the Cudgegong. But Schorl rock does occur there, and in the sands of Bahia, at Diamantina, in Minas Geraes; and this mineral, there called *feijao*, as well as hydrophosphate of alumina, is considered an indication of diamond.

It is stated by Mawe ("Travels in Brazil") that the mines of Cerro-do-Trio annually produced, between 1801 and 1806, to the amount of from 20,000 to 25,000 carats, and that the weight of those sent to the Treasury in Rio Janeiro was 115,675 carats.

As an encouragement to diamond seekers in this colony may be mentioned that numbers of the Brazilian crystals are so small that four or five make only a grain, so that it takes sometimes seventeen to twenty to weigh a carat. There are rarely in the course of the year more than two or three of the latter weight, and it takes two years to find one of 30 carats; so that when a negro workman found one of 17½ carats, called an *octavo*, he was crowned with flowers, conducted in triumph to the manager, fresh clad, and set at liberty. This is reported by Malte Brun (*Précis*, vol. iii., p. 293). Dr. Thompson has ascertained that up to January 12th, 1870, 9-10ths of the diamonds at the Two-mile Flat weighed less than a carat, and that 497 together weighed 120 carat grains; but as they were different in size, the average is assumed at one carat each, the largest being 1⅜ carats. One, however, had been found weighing 5½ carats.

These facts are interesting as correlating, so far as is known, the prospects of this colony and those of Brazil.

To prevent reference to it hereafter, I may mention now that a new and valuable work on precious stones ("Handbuch der Edelstein") was published in Vienna last year by Dr. Albrecht Schrauf. I found a notice of it in the *Quarterly Journal of Science* for January, 1870. In it is given a formula for calculating the value of diamonds, which tested by the price actually paid for the Sancy stone (£20,000), taking the weight at 53 carats, and the price of the first carat at £15 and which is near to the theoretical result (£21,862 10s.), appears to be tolerably correct. It is this:—

$$\frac{m}{2}-(m+2)a=\text{value},$$

where m is the number of carats, and a the value of one.

I have already noticed some of the facts stated by Messrs. Heusser and Claraz.

There are one or two others which may be quoted by way of relieving the dryness of these details. But I would mention that much compact information is given by these authors, in relation to their physical and geological researches in the interior of Brazil in Dr. Petermann's "Mittheilungen" (1859, Heft. xi.)

The previous and following quotations are taken from a paper read before the Geological Society of Berlin. Herodotus, we remember, tells (iii., 102), a ridiculous story, repeated by authors as late as the sixteenth century, of gold being brought up by ants as big as dogs that guarded it when obtained, and pursued the man that took it from them; but Messrs. Heusser and Claraz tell a far more probable story of diamonds having been found among the little pebbles with which some wormlike insects" cover their tubular coverings—a fact quite paralleled by the Phryganea of Auvergne, which covered their indusiæ with the shells of *Bulimus atomus* or a small *paludina*, forming strata which cover nearly 800 square miles, and are from eight to ten feet thick (*Scrope*, "Central France," p. 11).

There is, however, another statement of even greater interest. In the cascalhao are found fragments of quartz shaped like an anvil. These were used as earrings by the ancient inhabitants of Brazil. One of these ornaments was found in cascalhao that had never been disturbed, in a dry watercourse, covered by 18 feet of vegetable soil, on which many fine palm trees were growing. Arrow-heads and bones were also found with it. This cascalhao must, therefore, be comparatively recent, or the race to whom such implements belonged must have been very ancient.

According to M. Hockeder, the first diamond in Minas Geraes was discovered in the year 1827. But I believe Brazil was known to possess diamond just a century before.

The effect was much like that which takes place in Australia when a new lead is discovered. The gold workings were all deserted by what is called here "a rush," and the greatest excitement followed. M. Hockeder's memoir, though now little known, made also a stir at the time. [*Ueber des vorkommen der diamantem*]. There are other documents referred to in the *Bull. Soc. Geol. de France* (xiv., 232; i., 19; ii., 659).

Further particulars relating to the diamond beds of Brazil may be found in a paper by M. Pissis in the journal just cited (Tom. xiii).

One passage seems to bear upon certain facts observable in Australia. He says, "to these stratified rocks we must add compact diorites, which show themselves abundantly

distributed on the surface, sometimes forming long lines of hills, sometimes simple *mamelons* in which the matter appears to have been poured out in the manner of basalts, producing long sheets which cover the last beds of the limestones, whether siliceous or schistose." He then goes on to speak of the sandstones which underlie the limestones, and which are to be regarded as the true matrix of the diamond. "Thus, of all the rivers of the province of St. Paul those only which flow over the *sandstones* are diamond bearing." And instancing the Rio Guarahi, he says it leaps over the escarpment, where it forms several cataracts, cutting through the various beds of sandstones and psammites, and it is only below the cascades that you begin to find diamonds, a similar remark to that of M. Claussen in relation to the coal measures.

Other facts worthy of mention may occur in Captain Burton's work on the "Highlands of Brazil," but as I have never yet seen a copy of that work, I have not referred to it.

(To be continued).

ASSAY OF GOLD AND SILVER,

AS PRACTISED AT THE LABORATORY OF THE SCHOOL OF MINES, COLUMBIA COLLEGE.

By T. M. BLOSSOM, E.M.

(Continued from p. 16).

The Charge.

THE weight of ore taken for an assay depends upon its supposed richness or poverty, since it is required to obtain finally a bead of precious metal of convenient size for weighing, and, at the same time, neither too large for cupellation (*vide* Cupellation) nor so small as seriously to affect the calculated results, through losses sustained in the assay. As a rule, it is usual to take one-third assay ton for silver ores, and one, two, or four assay tons for gold ores.

A special method will be given for galena. All other ores require the following reagents:—Litharge, carbonate of soda, and one of the reducing agents, argol and charcoal, or an oxidising agent, as nitre, with invariably a cover of salt one-quarter to half an inch in depth. Borax, silica, and other reagents are very useful at times, but no general rule can be given for their employment. This matter must be left to the judgment of the assayer, guided by the known properties of the reagents and by the composition of the ore. It is well, in this connection, to bear in mind the principle that for basic impurities, an acid flux is needed, and for an acid gangue a basic flux. As a rule, employ a weight of litharge twice that of the ore, and of carbonate of soda, the same as of ore. These proportions also may be modified to advantage, according to the composition of the ore. The proportion of nitre, or of reducing agent, depends upon the reducing power of the ore, hence it is variable in every case. These reagents are added to control the size of the lead button.

Size of the Lead Button.—There are two limits to the size of the button: (1) it must be large enough, or, in other words, enough litharge must be reduced throughout the mass to collect all the precious metal, and, at the same time (2) there should not be a useless excess of lead, which would occasion loss of silver in the subsequent cupellation.

These two conditions cannot always be fulfilled, but in this case the latter must be sacrificed. It has been found that a button of 15 to 20 grammes is the best size for a weight of ore from one-third to four assay tons. This is also a convenient size for a cupellation. A button that is too large for cupellation can, however, always be reduced in size by scorifying.

These requirements necessitate, in many instances, a preliminary assay of the ore to determine its reducing power. The reducing power of an ore is due to the presence of sulphur, arsenic, antimony, zinc, &c., but generally to sulphur contained in pyrites, &c.

Preliminary Assay of Ore.

Charge.	Ore	2 grms.
	Litharge	25 ,,
	Carb. soda	10 ,,
	Salt	Cover.

A duplicate assay need not be made.

Warm the crucible before placing it in the fire, which should be perfectly bright and should be urged to effect complete fusion in the shortest possible time. When the contents of the crucible are in quiet fusion, it must be withdrawn, to prevent farther reducing action of the furnace gases. Tap the crucible gently, and when cold break it open.

Three cases may arise here. Two grammes of ore may yield—

1. No lead, or less than three grammes.
2. Three grammes lead.
3. More than three grammes.

The reducing power is stated thus:—2 grms. ore= — grms. lead. Let us suppose that we shall take for the regular assay ½ A. T. of silver ore and that the reducing power is found to be 2 grms. ore = 1·5 grms. lead: ½ A. T., or 10 grms. (about) ore will in this case reduce 7·5 grms. lead, and as the required button is 15 grms., we must add enough argol, or charcoal, to reduce 7·5 grms. in addition; taking argol as 8·5, we shall require 7·5÷8·5 grms. or 0·882 grms., say 1 grm., or charcoal 7·5÷28=0·268, say 0·3 grm.

If the reducing power correspond to the third case, a similar calculation will indicate how much nitre is needed to oxidise part of the sulphur, arsenic, or other reducing agent, and thus prevent the reduction of a button larger than 15 grammes. In the second case, ten grammes of ore would reduce a button of 15 grms. and neither argol nor nitre would be required.

The character of slag obtained in the preliminary assay may also suggest some modification of the regular charge. If it be earthy, for instance, we would add borax glass or silica. Experience will often enable the assayer to judge of the reducing power with sufficient exactness, without an extra assay. Cases will arise, however, in which he must make a preliminary assay, or roast the ore, and it is always best to roast when there is a large amount of sulphur in the ore. He will then have an ore of no reducing power.—(Case I.)

Ores to be Roasted.

Ores containing a large amount of sulphur or arsenic, antimony or zinc, should always be roasted. In the former case, if the ore be not roasted, there will be danger of the formation of oxysulphurets, which are very fusible, but are not decomposed even at a white heat, and enter the slag carrying silver with them. A large quantity of nitre also subjects the contents of the crucible to the liability of boiling over; even should this mishap not occur, the great evolution of nitrous and sulphurous vapours puffs up the mass throughout the crucible, and the globules of lead afterward reduced may be left adhering to the sides, not being washed down by the retreating charge. Arsenic and antimony produce arseniates and antimoniates, which carry silver into the slag. Zinc increases the loss of silver by volatilisation and also in the slag.

Roasting the Ore.

The ore may be roasted conveniently in a cast-iron pan over the crucible furnace. There ought to be a hood over the furnace, to carry off the fumes of sulphurous, arsenious, and other acids. The pan should be covered with a coating of red ochre, or, still better, of chalk. The former is put on wet with a brush. An excellent even coating of the latter may be obtained by

making a chalk paste, of proper consistence, in the pan, and turning with the hand so as to spread the paste while the pan is being held over the fire to dry. The coating prevents a loss of ore and injury to the pan through the sulphides attacking the iron.

The weighed sample must be spread over the pan and stirred with a bent wire until all danger of fusion is past. The pan must be heated gradually at first, not above a dull red heat for some time, and may be brought, finally, to a full red, or higher heat. Too high a heat at the outset might cause the fusion of sulphides and the formation of mattes troublesome to roast. A rapid disengagement of arsenic, antimony, or zinc, would cause, also, a mechanical loss of silver, by carrying it off in their vapours. Should fusion take place, it is better to weigh out a fresh portion of ore and roast again with more care. If this be not done the fused portions must be pulverised in a mortar and re-roasted. Generally, in roasting sulphides, the operation may be considered finished when, after keeping the pan at a full red heat for some time, no more fumes of sulphurous acid can be perceived. As there is danger, however, of the formation of sulphates, especially if copper pyrites be present, it is best always to mix some carbonate of ammonia with the ore, after the fumes have ceased, and to cover the pan. The ore is thus confined in an atmosphere of carbonate of ammonia, which decomposes the sulphates with formation of volatile sulphate of ammonia.

Arsenic and antimony require the addition of fine charcoal, to reduce any arseniates and antimoniates that may have been formed during the roasting. Care must be taken to burn out all the charcoal.

If the ore contain a very fusible sulphide, as antimony-glance or galena, it may be mixed with some fine sand previous to roasting.

The roasting of ores may also be done in the muffle in an earthen saucer.

Fusion.

The charge prepared according to the foregoing directions is thoroughly mixed and placed in a crucible, which it should not more than two-thirds fill. A hot fire should be employed, and the crucible removed when complete fusion has taken place. This ought to require from twenty to twenty-five minutes. The crucible is tapped, as usual, and broken when cold.

b. Scorification Assay.—

The reagents necessary for a scorification assay are test-lead and borax glass. The ore is mixed with these in suitable proportions, the mixture put in a scorifier and fused in a muffle. The operation affords an alloy of lead with the precious metals, and a slag composed of litharge with the impurities and gangue of the ore. The assay might be made with lead only, but it is advantageous, as will appear, to add some borax. There will be required of lead only enough to render the slag liquid and to furnish lead for the button. The proportions of both lead and borax will vary, and should be greater in proportion as the gangue and metallic oxides are more difficult of fusion. The following table exhibits the proportions found by experience to be best adapted to the different gangues. The proportions are referred to one part of ore.

Character of Gangue.	Parts Test-Lead.	Parts Borax.
Quartzose	8	
Basic (Fe_2O_3,Al_2O_3,CaO), &c.	8	0·25-1·00
Galena	5-6	0·15
Arsenical	16	0·10-0·50
Antimonial	16	0·10-1·00
Fahlerz	12-16	0·10-0·15
Iron pyrites	10-15	0·10-0·20
Blende	10-15	0·10-0·20

No preliminary roasting is required. As in the crucible assay, the weight of ore taken depends very much upon its richness, but is generally a third, sixth, or tenth of an assay ton. If one scorifier will not contain the charge, it is best to weigh equal fractional parts for the number required, rather than to weigh the whole charge and roughly divide it between the scorifiers. In case of an accident to one of the scorifiers, the known loss can easily be restored, if the former course be followed. The exact parts that lead and borax perform in scorification can be understood best from a description of the operation in detail.

Three distinct periods may be noted in the working:—

1. Roasting; 2. Fusion; 3. Scorification. A strong heat is maintained, at first, in order to melt the lead. This is effected by closing the muffle and regulating the draught. As soon as the lead is fused the muffle is opened, and the ore is seen floating upon the surface of the lead.

1. The roasting now commences, and is continued at a moderate heat until no more fumes are seen, and the ore has disappeared.

2. The heat should now be raised in order to fuse thoroughly all the material in the scorifier. When the fusion is complete, clear white fumes of lead may be seen arising from the scorifier, there is an intermittent play of colours across the bright surface of the lead, and the slag produced encircles the metallic bath like a ring. The borax plays an important part just here, by giving liquidity to the slag, thus permitting it to be thrown to the side as fast as formed, exposing a clear surface of lead for oxidation. If borax be not added and the ore contain a difficultly fusible gangue, the scoriæ will float in detached masses over the lead, impeding the oxidation, until sufficient litharge has been formed to give it liquidity.

3. When the fusion is complete, the heat may be lowered and the third period of scorification continued until the ring of slag, which is continually growing smaller, close over the residue of metallic lead. The heat should again be raised, to liquefy the slag and allow the metallic lead to settle, after which the scorifier is removed from the furnace. If the button is wanted immediately for cupellation, the contents of the scorifier may be poured into an iron or copper mould coated with red ochre. It is thus soon cooled. Otherwise allow the contents to solidify in the scorifier, and break this for the button when cold. Hammer the button as usual.

The whole assay occupies about thirty-five minutes.

In making the charge, it is customary to mix the ore with a part of the test-lead and with borax, and to cover this in the scorifier with the rest of the lead. This will prevent loss of ore prior to fusion. Too much borax should not be added at first. If a large amount is needed, it is better to mix only a portion with the ore, one gramme, for instance, and to introduce the rest wrapped up in paper, as needed during the operation. Some of it may be reserved for the final heating after the lead is slagged over. If too much were added at first, the lead would be slagged over before the necessary reactions had taken place.

The Lead Button.—The lead button submitted to cupellation must be malleable and of the proper size for the cupel. A good cupel will absorb its own weight of litharge, but it is better to use a cupel one-quarter to a third as heavy again as the lead button. The cupels in ordinary use weigh about 18 grammes, hence a button of 12 to 15 grammes is the proper size for them. If the button be too large it may be reduced in size by scorification. In case of doubt it is better to scorify, since there is less loss in this operation than in cupellation. A brittle button may be due to the presence of sulphur, arsenic, antimony, zinc, or litharge. In either case it must be scorified before cupellation, and with test-lead if necessary. If the button contain copper it must be scorified until no more copper can be seen on hammering out the button. If nickel be present the button cannot be cupelled. This, however, will occur but rarely:

3. *Cupellation.*—

The lead button obtained by the foregoing operations is next cupelled. This operation is similar in many respects to scorification, but differs from it in that the scoriæ formed are absorbed entirely by the cupel, leaving a pure bead of the precious metals. This property of the absorption of scoriæ is an indispensable condition in cupellation, so that, unlike scorification, it is limited to a few substances capable of being absorbed by the cupel. The oxides of lead and bismuth alone can be absorbed in a state of purity, but they can carry along with them certain proportions of other substances which, by themselves, would form infusible scoriæ. It is thus that we are enabled to get rid of small amounts of copper, iron, arsenic, &c., remaining in the lead button. Bismuth is seldom, if ever, used for this purpose. The proportion of lead required to carry off the different impurities varies according to circumstances. In the case of lead buttons from an assay, there is always an excess of lead, if they have been properly purified. Other cases will be treated under the head of Assay of Alloys, where the necessary tables will be given.

The operation of cupelling a lead button is conducted as follows:—

The cupels must be carefully dried before use, and must be free from cracks, which would cause a loss of precious metal. The bottom of the muffle should be covered with sand, to prevent injury to it in case of the upsetting of a cupel. A cupel having been selected, it should be wiped carefully with the finger, and all extraneous matter blown out. It may then be placed in the muffle. Before the introduction of the lead button, the muffle should have attained a reddish-white heat, and the cupel should be of the same temperature. This being attained, the button is placed in the cupel with a pair of forceps, gently, so as not to injure it. The muffle should now be closed, either by a door or by a piece of lighted charcoal, to bring the fused button to the same temperature. This done, the muffle is opened and air allowed to enter; the button, which at first appears bright and uncovered, is soon covered with a film of oxide moving in luminous patches over the surface, and being continually thrown toward the edge, where it is absorbed by the cupel. White fumes of lead arise, and the button is surrounded by a ring of the absorbed litharge, which continually widens until it reaches the edge of the cupel. The button thus gradually diminishes in size by oxidation and absorption, and becomes more convex; the luminous patches become larger and move more quickly; and when, finally, the last of the lead is absorbed, the button appears to revolve rapidly on its axis, becomes very brilliant, and is suffused with all the tints of the rainbow; the movement is suddenly checked, the button becomes dull for a few instants, and then presents the appearance of the pure precious metals. The latter part of the operation is called the "brightening" of the button. Should the bead be large, and composed, in great part at least, of silver, it must be removed slowly and gradually from the furnace, to prevent loss by "spitting," which might happen if the cupel were removed at once from the muffle. When a cupel is withdrawn directly after brightening, the button is liable to be covered by mammilated and crystalline protuberances, and is then said to have "vegetated" or "spit." Portions of the metal are sometimes thrown off and lost. Whatever the cause may be, this does not occur if the button be withdrawn gradually, so as to permit a slow and gradual cooling. In case the bead be very large, say 100—300 milligrammes, it is well to cover it with a hot cupel, which will retard the cooling and prevent the loss of small particles that may be thrown off despite all care. If the bead is not larger than the head of an ordinary pin, the danger of vegetation is slight, and no great precautions need be taken in its removal.

Two causes have been assigned for this "spitting." One is that molten silver absorbs oxygen from the atmosphere and gives it up at the moment of solidifying, thereby occasioning the vegetation. Another is, that by rapid cooling a crust is formed on the outside, which contracts upon the liquid interior and is broken, forcing the molten metal through the rents thus made. The latter is simple and plausible; the former is supported, apparently, at least, by elaborate experiments.

It is well to raise the heat of the furnace just before the brightening, or to push the cupel into a hotter part of the muffle, in order to aid the brightening and get rid of the last traces of lead, which are somewhat difficult to remove. The button should also, for the latter purpose, be heated strongly a few seconds after brightening.

Silver is sensibly volatile at a high heat; the loss of gold is slight, and may be disregarded. In the assay of ores this loss need not be considered, but in bullion assay a correction is necessary, for which a table will be given under Assays of Alloys. The loss of silver increases with the temperature, but we must avoid, in cupellation, the two extremes of a high heat and quick work and a low heat with prolonged work. Of the two extremes the latter is worse. The following are indices of favourable working:—The muffle is reddish-white, the cupel is red, the fused metal very luminous and clear, the lead fumes rise slowly to the top of the muffle, and the litharge is completely absorbed by the cupel.

The heat is too great when the cupels are whitish, when the fused metal is seen with difficulty, and the scarcely-visible fumes rise rapidly in the muffle.

The heat is too low when the fumes are thick and fall in the muffle, and when the unabsorbed litharge is seen forming lumps and scales about the button.

The degree of heat should bear some relation to the richness of the alloy, and may be greater according as the lead is poorer in silver. By bearing this in mind the assayer may often hasten the operation without detriment to the assay. The draught of air through the muffle must also be regulated. Too strong a current cools the cupel and oxidises the lead faster than it can be absorbed, thus endangering the assay. Too slow a current prolongs the operation and increases the loss by volatilisation. In ordinary work this matter, however, occasions very little trouble.

It happens sometimes that the material in the cupel becomes solidified in the midst of an operation, stopping all farther action. This disaster is called the "freezing" of the button, and is occasioned by the following conditions; a production of litharge more rapidly than it can be absorbed by the cupel, and infusible scoriæ, due to a cold furnace, or to an excess of foreign oxides. In either case the scoriæ gradually extend over the surface of the button until it is entirely covered, when farther movement ceases. This disaster may sometimes be prevented or remedied by raising the heat of the muffle; if this fails, or if the accident be due to foreign oxides, an addition of pure lead must be made to the assay; in either case, the results are unreliable.

An assay that has *passed* well, furnishes a bead well rounded and clear, crystalline below, and readily to be detached from the cupel. If the bead contain lead, it is brilliant below, and does not adhere at all to the cupel. If the bead exhibits rootlets passing down into the substance of the cupel, the results are inaccurate.

(To be continued.)

MISCELLANEOUS.

Stevens's Institute of Technology, Hoboken, N.J.—The first session of this institute, of which Professor Henry Morton is the President, will commence on the 26th of September. Apparatus, &c., already purchased amounts to upwards of £5000.

Trial of the Pyx of the Mint.—On Tuesday, July 18th, this ancient and interesting trial was held at the Goldsmiths' Hall, the proceedings, commencing at nine o'clock, a.m. The following is an extract from the verdict of the

Jury:—"We then assayed the six sovereigns, and three half-sovereigns separately, and we found the millesimal fineness of such sovereigns to be 916·9, 916·7, 916·7, 916·8, 916·7, 916·7 respectively, and the millesimal fineness of such half-sovereigns to be 916·6, 916·6, 916·5 respectively." The true standard of gold is 916·66 parts of fine gold in 1000 of alloy; therefore the result of the trial is truly wonderful, and reflects great credit on the responsible officer, Mr. W. Chandler Roberts, the chemist to the Mint. The bulk of the silver coins agreed exactly with the standard trial plate, although the law allows a variation of eight parts in the thousand.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, June 26, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences;—

Memoir on the Transport of some Salts by Electrical Discharge.—Dr. Becquerel.—This lengthy essay treats on some phenomena observed by the author while experimenting on the effect of only moderately strong electrical discharges when certain chemical compounds are placed in the route of the electric current. As results from these experiments, the author finds that the undermentioned salts and other chemicals are transported by electrical discharges in the direction from the negative electrode to the positive electrode, but not again the reverse way. These salts and substances are ferricyanide of potassium, bichromate of potassa, chloride of barium, chloride of sodium, chloride of potassium, sulphuric acid, phosphoric acid, chloride of ammonium, and protochloride of iron. The following are among the substances which are not transported by any electric current, whatever its direction:—Chloride of cobalt, chloride of platinum, nitrate of silver, caustic potassa, and sulphate of potassa.

Relation existing in the Sun between the Faculæ, Protuberances, and Corona.—Rev. A. Secchi, S.J.—A lengthy letter by the eminent *savant* communicating his latest discoveries on the physical constitution of the sun. This preliminary notice is to be followed by a complete essay on this subject.

Experimental Researches on the Preparation and Properties of the Propylic and Butylic Chlorides.—J. Pierre and E. Puchot.—This very lengthy memoir describes exhaustively the various methods of preparation employed by the authors for obtaining—(1) Propylic chloride, C_3H_7Cl, a liquid which, in a pure state, is colourless, very mobile, exhibiting a not unpleasant, yet somewhat alliaceous (garlic-like), odour, and boils at 46°5; its density at 0° is 0·9156, and at 39° 0·8671. (2) Butylic chloride, C_4H_9Cl; also a liquid which, in many of its properties, is similar to that just alluded to, but boils at 69°, and has at 0° a sp. gr. of 0·8953. The authors are engaged in making further researches on some of the products of decomposition of these fluids, only briefly alluded to in this paper.

Researches on Animal Amidon, a Starch-Like Substance.—C. Dareste—This paper is a physiological essay on the occurrence of a microscopically-small granular substance which has been observed by the author to be present in the yolk of eggs, the ovary, liver, and other organs of animals, and which substance, in many of its chemical and physical properties, exhibits a similarity to starch.

Second Memoir on the Heat Evolved by the Combustion of Magnesium, Indium, Cadmium, and Zinc.—A. Ditte.—An algebraico-physical memoir.

This number contains also several important meteorological papers, and an interesting account of the fate of the balloons started from Paris during the siege of that city by the Germans.

July 3, 1871.

This number opens with a very lengthy and highly valuable memoir on the—

Heating and Ventilation of the Palace of the Corps Législatif during the Session 1869-70.—General Morin.

The other original papers and memoirs relating to chemistry and collateral sciences are—

Reactions which take place between Oxide of Carbon under the Joint Action of Metallic Iron and the Oxides of that Metal.—L. Gruner.—Reserved for translation and full reproduction.

Monochlorides of the Bibasic Acids.—L. Henry.—This essay, however valuable in a scientific point of view, is not well suited for any useful abstraction, owing to the large number of formulæ absolutely required for the proper elucidation of the subject.

Properties and Industrial Manufacture of Nitroglycerine.—P. Champion.—From this very lengthy memoir we quote the following particulars bearing upon the properties of nitroglycerine, which is absolutely insoluble in water, but soluble, in all proportions, in ether, methylic alcohol, and ordinary alcohol (but, as regards the latter, only at a temperature above 50°). Nitroglycerine is somewhat volatile, without decomposition, above 100°, and is not liable to spontaneous decomposition when pure. When exposed for several hours to a temperature of −15°, nitroglycerine becomes thick, but not solid; while a prolonged continuation of cold of only −2° freezes this body, converting it into a crystalline mass. Fuming nitric acid dissolves, but also decomposes this fluid; and the same effect is produced by concentrated sulphuric acid, and also by the mixture of sulphuric and nitric acids employed for the preparation of nitroglycerine. This latter fact explains the deficiency of the theoretical quantity (246) which is obtained in the preparation of nitroglycerine from 100 parts of glycerine. Nitroglycerine is also decomposed by aqua regia, by ordinary nitric acid at 50°, and by a concentrated solution of caustic soda, a nitrate of that base being formed. The author's experiments prove that pure nitroglycerine boils, but does not explode violently, at 185°; volatilises slowly at 194°, rapidly at 200°; deflagrates violently at 217°; detonates difficultly at 241°, but violently and completely at 257°; at a higher temperature the detonation is less violent, and at 287° is accompanied by flame. At low red heat, nitroglycerine assumes the spheroidal state, and is volatilised without detonation. While nitroglycerine detonates with great violence by a smart blow, it is not affected by electrical shocks.

Iodo-Chromate of Potassa.—P. Guyot.—The author describes, at some length, the mode of preparation of the salt alluded to, $2(CrO_3)IK$, or—

$$CrO_4'' \left\{ \begin{matrix} OK \\ I \end{matrix} \right.$$

stating that this salt usually contains an excess of iodine, and is decomposed in contact with water. The best mode of preparation of this salt, so as to obviate excess of iodine and obtain the salt crystallised, is to heat gradually, but without ebullition, a saturated solution of iodhydric acid with pulverised chromate of potassa, to be added by small portions at a time, and to cool slowly the porcelain vessel wherein the operation is performed.

Xanthine, and its Detection in Vesical Calculi.—G. Lebon.—A physiologico-chemical paper. Xanthine, ($C_{10}H_4N_4O_4$), is a substance found in very small quantity in urine, but very rarely met with in vesical calculi.

Moniteur Scientifique, Nos. 347 and 348 (double number), June 1 and 15, 1871.

This number opens with an exhaustive essay on the—

Treatment to be Adopted in Cases of Adder Bites.—Dr. A. Viaud-Grand-Marais.—This essay contains a large amount of useful and well-digested matter. Fortunately, in the United Kingdom poisonous snakes are rare; whereas, in many parts of France they are so abundantly met with as to make it necessary for the authorities to pay a premium of from 1 to 2 francs for every killed snake exhibited and given up during a certain period of the year.

The original papers bearing upon chemistry and collateral sciences are the following:—

Separation of Silver from Argentiferous Lead.—Dr. E. Kopp.—This lengthy memoir treats first on the process of extracting silver from lead by means of zinc, and contains next a description of MM. Rothschild's large works established at Havre for the purpose of refining every month some 500 tons of Spanish lead by means of zinc, followed by descriptions of similar works established in the Harz and Upper Silesia, and, lastly, the description of the works of MM. Herbst Bros., at Call. This excellent essay is too lengthy to admit of any useful abstraction, and, unfortunately, also for translation in full.

Use made of Finely-Divided Metallic Tin.—Dr. E. Kopp.—Very finely-divided tin is prepared by the decomposition of a solution of a proto-salt of tin, by means of metallic zinc, in the following manner:—Into some 15 to 20 cylindrically-shaped earthenware jars capable of containing 12 litres are poured from 8 to 10 litres of a solution of chloride of zinc at a density of from 10° to 15° B. (sp. gr., 1·070 to 1·109), to which are added from 40 to 70 grms. of tin-salt (protochloride of tin), after which stout pieces of sheet zinc are placed in this liquid. The reduction of the tin takes place gradually; and as soon as the reaction is finished the liquid is cautiously poured on a fine silk sieve. The filtrate is again used, and the metallic tin is first washed by decantation, and the very finely-divided metal is next collected on a filter, washed once more with distilled water, and afterwards dried. The substance thus obtained is chiefly used in the production of the so-called argentine printing, either upon silk or fine cotton fabrics (fine muslins and *mousselines de laines*), the very finely-divided metal being fixed either by means of albumen or an ammoniacal solution of caseine. After printing and dressing, the fabric, in order to give the metallic silvery gloss, is hot-pressed. A very large quantity of this finely-divided tin is also used in the manufacture of surface-metallised paper, and for the purpose of ornamenting gilt picture-frames.

Method of Rendering Wooden Taps Impervious for Liquids and Preventing their Cracking.—Dr. E. Kopp.—The taps are placed in molten paraffin heated to from 110° to 120°; by this means

the water is eliminated from the wood, and the wood becomes thoroughly impregnated with paraffin. The taps are not removed from this bath until all the aqueous vapour has been expelled and left, after the removal of the vessel from the fire, in the molten liquid up to the very moment the paraffin begins to solidify. Wooden taps thus prepared are very durable, do not become soaked with liquids, keep very tight, and are not liable to become mouldy. The excess of paraffin is wiped off with care, and the taps are next rubbed clean with a piece of flannel.

Animal Charcoal, and its Use in Sugar Refining.—A. Vivien.—This valuable essay contains a very large amount of useful practical matter, but the paper is too lengthy to admit of any useful abstraction.

Testing by means of the Blowpipe.—F. Jean.—The author states that sulphuret of sodium is one of the best blowpipe tests, if used in the following manner:—First, a bead is made with borax and the substance to be tested, and this bead, having been made very fluid within the reduction-flame, there is added to it some dry and pulverised polysulphuret of sodium, and the bead again heated in the reduction-flame. If the substance under investigation can form a sulpho-acid, there will be formed a soluble sulpho-salt and a clear bead; but when no such salt can be formed, with lead, for instance, an opaque bead will be formed. Iron, lead, bismuth, nickel, cobalt, palladium, thallium, silver, copper, uranium, &c., fused in a bead of borax, to which, afterwards, sulphuret of sodium is added, will yield a black or brown-coloured opaque bead; zinc yields a white opaque bead; cadmium, while yet hot, scarlet-red, and yellow after cooling; manganese a dirty chestnut-brown; gold and platinum, a clear, transparent, mahogany-brown bead; tin, a clear, transparent, yellowish-brown bead; chromium, a green bead; arsenic and antimony, colourless clear beads; vanadium and iridium, blood-red beads; a slight excess of the sulphuret of sodium is required, and the bead should be heated carefully, but steadily, and with a good blast in the reduction-flame.

La Revue des Scientifique de la France et de l'Etranger, July 15, 1871.

This number does not contain any original papers on chemistry and collateral sciences.

Polytechnisches Journal von Dingler, first number for June, 1871.

The original papers and memoirs relating to chemistry and collateral sciences contained in this number are—

Phosphorus Bronze.—MM. Montefiori-Levy and Kimtzel.—This paper treats on a subject which (as proved, also, in the appendix added to this paper by the editor of this periodical) has been frequently a subject of research and of trials on the large scale—to wit, the addition of a certain proportion of phosphorus to either copper alone, or to an alloy of copper and tin with or without any zinc. It appears that the authors have hit upon a plan for manufacturing an alloy, of which phosphorus is one of the constituents; but this paper does not give any information on the chemical composition of this alloy, which appears, however, from experiments made with it, to be exceedingly well adapted for the construction of some parts of machinery, and also for the purpose of making carbine and rifle barrels.

Separation of Oxide of Iron from Oxide of Uranium, and the Estimation of Phosphoric Acid by means of Uranium.—H. Rheineck.—Reserved for full translation.

Best Means of Improving Fireclays, so as to render them more Suited for the Manufacture of Glass, as well as for General Purposes.—Dr. C. Bischof.—The contents of this paper altogether bear upon matters of practical detail in respect of the manufacture of fireclay articles. Among the means of rendering these less readily fusible, and acted upon by the constituents of glass, the author mentions the judicious application of the powder of broken seggars and glass pots.

Flückiger's Reactions of Water-Glass.—Dr. Thüssing.—In order to understand the contents of this paper, we refer our readers to Chemical News, vol. xxii., pp. 239 and especially 263, where Dr. Flückiger's experiments are quoted. The author of this paper, having repeated some of these experiments, states that a chemical action between the neutral salts of the fixed alkalies and water-glass, whereby free silica should be separated, is not at all likely to occur, but that it is more probable that these salts will behave with water-glass in a manner akin to their behaviour with soaps, and that, consequently, the precipitate, instead of being free hydrated silica, is an alkaline silicate. This the author has proved by experiment, for, on treating, according to Dr. Flückiger's plan, a solution of water-glass with ammonia, the gelatinous precipitate, properly washed by means of Bunsen's pump, was, on analysis, found to consist, in 100 parts, of—Silica, 79·38; soda, 20·62; corresponding to a formula, $4SiO_2 1Na_2O$. Water-glass (silicate of soda), treated with nitrate of soda, yielded a precipitate consisting, in 100 parts, of—Silica, 53·81; soda, 13·90; water, 32·29. Formula, $4SiO_2 1Na_2O 8H_2O$.

Estimation of the Value of Oil-Seeds.—Dr. H. Vohl.—This paper is an appendix to the author's former paper on this subject (see Chemical News, vol. xxiii., p. 287). From the contents of the paper now before us, we learn that the average quantity of oil contained in the following seeds is, in 100 parts—Linseed, 27·153; hemp-seed, 25·875; poppy-seed, 49·403; walnuts, 50·06; almonds, 52·416; seeds of grapes, 17·956. The sp. gr. of these oils, in pure state, at 15° is—For linseed oil, 0·9347; hemp-seed, 0·9276; poppy-seed, 0·9247; walnut oil, 0·9264; almond oil, 0·9180; grape-seed oil, 0·9222. There are added to this paper some particulars on the mode of conducting the quantitative extraction of the oils from the seed, and a very useful tabulated index for calculating the quantity of oil contained in the oil-bearing seeds according to the specific gravity of the Canada oil extract of the seeds at 15°. By Canada oil is meant a kind of petroleum spirit of 0·680 sp. gr.

Although not strictly belonging to the subjects usually treated of in our journal, we think it may interest some of our readers to have their attention called to—

General Police Regulations concerning the Construction and Measures for Safety of Steam-Boilers for the North-German Confederation.—This document, clearly and concisely written, is a valuable contribution to what is properly and tersely termed *Administration de la sureté et salubrité publique.*

Malleable Iron Gas Retorts.—Dr. Dingler.—The author states that such retorts, forged at the ironworks at Kaiserslautern (Bavaria), are now in use at several large German gasworks, inclusive of that newly built at Frankfort-on-the-Maine, and that these retorts, besides being far less heavy, are also far more durable than cast-iron retorts.

Contamination of Chloride of Barium with Hyposulphite of Baryta.—Dr. Wittstein.—The author found this impurity in the chloride of barium employed in his laboratory; he explains the presence of this substance in chloride of barium in the following manner:—When chloride of barium is prepared from sulphuret of barium, and this latter not quite completely decomposed by hydrochloric acid, any undecomposed sulphuret of barium is gradually converted into hyposulphite of baryta, which, unless the chloride is purposely re-crystallised, remains mixed with the chloride.

Application of Neutral Water-Glass (Silicate of Soda or of Potassa) for the Purpose of Washing Wool.—Von Baerle and Co.—This paper mainly states that neutral water-glass (as purposely prepared by the parties just named), 1 part, and 40 of water, heated to from 50° to 57°, is one of the best and also cheapest means of washing wool. The same substance (viz., this water-glass) is recommended instead of soda and soap for domestic washing purposes.

Tannin as a Substitute for Hops in certain kinds of Beer.—Dr. Dingler.—The use of hops in brewing is partly necessitated by the clarifying action it exercises. Now the author states that 15 grms. of tannic acid have in that respect the same effect as 1 lb. of hops, and that, therefore, where it is desired to brew a sweet-tasted beer, hops may be replaced by tannin previously dissolved in from eight to ten times its weight of water.

American Journal of Pharmacy, July, 1871.

Besides papers and memoirs more directly relating to pharmacy, this number contains the following original ones relating to chemistry:—

On Cundurango.—Dr. T. Antisell.—The contents of this paper describe some experiments made by the author with samples of a vegetable product, wood and bark, obtained from Loja, a province of the State of Ecuador, known locally as *cundurango*, and stated to be a remedy of great value in cancer, fungus hæmatodes, and constitutional syphilis. The bark (the medicinal virtues of the product appear to be therein contained) was found to consist of—Water at (100°), 8 per cent; mineral matter, 12 per cent; vegetable substance, 80 per cent; this latter being separable into—Fatty matter, soluble in ether and partially in strong alcohol, 0·7; yellow resin, soluble in alcohol, 2·7; gum and glucose from starch, 0·5; tannin, yellow and brown colouring matters (extractive), 12·6; cellulose, lignin, &c., 63·5; no crystal, alkaloid, or active principle was found, and no volatile oil. The botanical characters of the cundurango-producing tree or shrub are unknown.

Examination of Sub-Nitrate of Bismuth.—J. D. Owen.—The author, having been requested to make an examination of the substance just named—the *bismuthum hydrico nitricum* of the Pharmacopœæ; formula, $4BiO_3NO_5 9HO$—tested four samples, the composition of which was found to be as follows:—BiO_3NO_5—79·20, 77·07, 73·44, 76·90; BiO_3HO—18·33, 21·24, 23·88, 15·48; $BiCl_3+2(HO,BiO_3)$—1·36, 5·94 (two other samples, only a trace); AgCl—0·37 (other three samples, only a trace); arsenic in all, only a trace; water uncombined—0·74, 1·69, 2·68, 1·68.

Synanthrose, a New Carbo-Hydrate.—O. Popp.—From dahlia tubers the author has prepared a substance which he calls synanthrose, a white, amorphous, deliquescent substance, readily soluble in water and dilute alcohol, insoluble in ether, insipid, and without action upon polarised light; it is decomposed by dilute acids into dextrose and levulose, has then a sweet taste, and is then directly fermentable; it is coloured black by concentrated sulphuric acid in the cold, but is not turned brown by caustic potassa at the ordinary temperature. Nitrate of silver produces, in the cold, a white flocculent precipitate; on heating, reduction takes place. Mercurous salts are reduced in the cold. The compounds with lime and baryta are soluble in water, but insoluble in alcohol. The formula of synanthrose is $C_{12}H_{22}O_{11}$; that of the baryta compound, $C_{12}H_{20}BaO_{11}$. This substance (synanthrose) prevents the precipitation of cupric, ferric, and chromic oxides by alkalies; freshly-precipitated ferric oxide is dissolved by a solution of synanthrose.

Programm der Königlichen Rheinisch-Westphälischen Polytechnischen Schule zu Aachen, für den Cursus, 1871-72.

We owe to the politeness of the excellent director of this establishment the opportunity of once more calling attention to the Royal Rhenish-Westphalian Polytechnic School founded at Charlemagne's ancient and favourite city of Aix-la-Chapelle (Aachen). The pro-

gramme before us, a volume of 112 large octavo pages, exclusive of two large-sized tabulated forms, is valuable also as an example of what polytechnic instruction really means. The course of instruction intended to be given at the Polytechnic School at Aachen, from the 9th of October next, is plainly described in this volume, to which a loose sheet is added containing well drawn up hints and good advice for those who desire to attend the instruction of a polytechnicum, as it is properly termed. The various subjects on which lectures and practical instruction are given embrace no less than sixty different branches, and include, not only all matters relating to mathematics, geometry, and physical sciences, but also everything required by the civil and mechanical engineer, architect, industrial and technical chemist, metallurgist, and mining engineer, including a subject for which there is no single equivalent word in English—"salinenkunde"—that is to say, all things relating to the extraction of salt from saline springs and the working of salt deposits; further, also, electrical telegraphy, practical instruction in the construction of chemical and metallurgical works; political economy, stenography, anatomy, and physiology; special "*gewerbe sanitäts polizei*"—that is to say, the manufacturing industry considered in its relation to, and bearing upon, the health and well-being, as well of the workmen, artisans, and labourers employed as of the rest of the population, and also treating on the requirements of public and other buildings in respect of ventilation, lighting, heating, &c. The Polytechnic School possesses excellent libraries, laboratories, workshops, museums, and collections of various kinds, to which donations of high value from various countries and private individuals (185 in number) have been added during the past year, a complete catalogue of which is published at the end of the programme. Space forbids us to enter here into more details, but we must not omit to state that, according to the *palmam qui meruit ferat*, everything has been and is being done to make this Polytechnic School a focus of attraction, not only for Germans, but for students from all parts of the world who are desirous of obtaining sound theoretical and practical instruction, as applied to arts, manufactures, mines, and engineering.

Journal für Gasbeleuchtung und Wasserversorgung, No. 12, 1871.

This number does not contain any other original papers than those strictly relating to the subjects of gas- and water-works' management and engineering. For those who may be interested in such matters, we call attention to a paper on the—

Yield and Consumption of Petroleum in America and other parts of the World.—Dr. Schilling.—This paper contains, in a condensed form, a valuable amount of statistical information on the subject alluded to.

NOTES AND QUERIES.

Anthracene.—Would you kindly inform me of a good method of separating anthracene for the heavy oil of tar, a method of purifying the same, and its uses?—HENRY DORSETT.

Cement to Resist Nitric Acid.—Will you kindly inform me what is the best cement to make the joints of a stone cistern to resist nitric acid?—T. KENYON, jun.

A New Form of Mariner's Compass.—I understand that, at a recent sitting of the French Academy of Sciences, a curious communication was received from M. Zalewski, which, if borne out in practice, would be invaluable to navigation. He states that if a hollow cylinder made of thin materials, open at the top, and provided with a sharp-edged bottom, be properly ballasted, and then put into a tub or other vessel filled with water, it will soon move in a never-varying direction from west to east! The round tin boxes in which concentrated milk is preserved will do perfectly for the experiment, which will become more and more perceptible the oftener the same cylinder is employed in the experiment. Can any of your readers give me additional information on this subject?—ALPHA.

TO CORRESPONDENTS.

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J. B.—Dr. R. Angus Smith, of All Saints, Manchester, is the principal inspector under the Alkali Act.

J. Reddrop.—It should have been "carbon;" the meaning is, however, apparent.

Agri. Chem.—In the *Journal of the Chemical Society*.

H. B. Yardley.—Roscoe's "Spectrum Analysis."

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THE CHEMICAL NEWS.

Vol. XXIV. No. 610.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Edinburgh Meeting, August 2, 1871.

INAUGURAL ADDRESS OF THE PRESIDENT,

Sir William Thomson, Knt., LL.D., F.R.S., &c.,
Professor of Natural Philosophy in the University of Glasgow.

My Lords, Ladies, and Gentlemen,—

For the third time of its forty years' history the British Association is assembled in the metropolis of Scotland. The origin of the Association is connected with Edinburgh in undying memory through the honoured names of Robison, Brewster, Forbes, and Johnston.

In this place, from this chair, twenty-one years ago, Sir David Brewster said:—"On the return of the British Association to the metropolis of Scotland I am naturally reminded of the small band of pilgrims who carried the seeds of this Institution into the more genial soil of our sister land. . . . . Sir John Robison, Professor Johnston, and Professor J. D. Forbes were the earliest friends and promoters of the British Association. They went to York to assist in its establishment, and they found there the very men who were qualified to foster and organise it. The Rev. Mr. Vernon Harcourt, whose name cannot be mentioned here without gratitude, had provided laws for its government, and, along with Mr. Phillips, the oldest and most valuable of our office-bearers, had made all those arrangements by which its success was ensured. Headed by Sir Roderick Murchison, one of the very earliest and most active advocates of the Association, there assembled at York about 200 of the friends of Science."

The statement I have read contains no allusion to the real origin of the British Association. This blank in my predecessor's historical sketch I am able to fill in from words written by himself twenty years earlier. Through the kindness of Professor Phillips, I am enabled to read to you part of a letter to him at York, written by David Brewster from Allerly by Melrose, on the 23rd of February, 1831:—

"Dear Sir,—I have taken the liberty of writing you on a subject of considerable importance. It is proposed to establish a British Association of men of science similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful sovereigns of that part of Europe. The arrangements for the first meeting are in progress; and it is contemplated that it shall be held in York, as the most central city for the three kingdoms. My object in writing you at present is to beg that you would ascertain if York will furnish the accommodation necessary for so large a meeting (which may, perhaps, consist of above 100 individuals), if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town and in the vicinity would be likely to promote its objects. The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

Of the little band of four pilgrims from Scotland to York not one now survives. Of the seven first Associates, one more has gone over to the majority since the Association last met. Vernon Harcourt is no longer with us; but his influence remains, a beneficent, and surely, therefore, never dying, influence. He was a geologist and chemist, a large-hearted lover of science, and an unwearied worker for its advancement. Brewster was the founder of the British Association; Vernon Harcourt was its law-giver. His code remains to this day the law of the Association.

On the eleventh of May last, Sir John Herschel died in the eightieth year of his age. The name of Herschel is a household word throughout Great Britain and Ireland—yes, and through the whole civilised world. We of this generation have, from our lessons of childhood upwards, learned to see in Herschel, father and son, a *præsidium et dulce decus* of the precious treasure of British scientific fame. When geography, astronomy, and the use of the globes were still taught, even to poor children, as a pleasant and profitable sequel to "reading, writing, and arithmetic," which of us did not revere the great telescope of Sir William Herschel (one of the hundred wonders of the world), and learn with delight, directly or indirectly from the charming pages of Sir John Herschel's book, about the sun and his spots, and the fiery tornadoes sweeping over his surface, and about the planets, and Jupiter's belts, and Saturn's rings, and the fixed stars with their proper motions, and the double stars, and coloured stars, and the nebulæ discovered by the great telescope? Of Sir John Herschel it may indeed be said, *nil tetigit quod non ornavit*.

A monument to Faraday, and a monument to Herschel, Britain must have. The nation will not be satisfied with anything, however splendid, done by private subscription. A national monument, the more humble in point of expense the better, is required to satisfy that honourable pride with which a high-spirited nation cherishes the memory of its great men. But, for the glory of Faraday or the glory of Herschel, is a monument wanted? No!

> What needs my Shakespere for his honoured bones
> The labour of an age in piled stones?
> Or that his hallowed reliques should be hid
> Under a star-ypointing pyramid?
> Dear son of memory, great heir of fame,
> What need'st thou such weak witness of thy name!
> Thou, in our wonder and astonishment,
> Hast built thyself a live-long monument.
> * * * * *
> And, so sepulchred, in such pomp dost lie,
> That kings for such a tomb would wish to die.

With regard to Sir John Herschel's scientific work, on the present occasion I can but refer briefly to a few points which seem to me salient in his physical and mathematical writings. First, I remark that he has put forward, most instructively and profitably to his readers, the general theory of periodicity in dynamics, and has urged the practical utilising of it, especially in meteorology, by the harmonic analysis.

Sir John Herschel's discovery of a right or left-handed asymmetry in the outward form of crystals, such as quartz, which, in their inner molecular structure, possess the heliçoidal rotational property in reference to the plane of polarisation of light, is one of the notable points of meeting between natural history and natural philosophy. His observations on "epipolic dispersion" gave Stokes the clue by which he was led to his great discovery of the change of periodic time experienced by light in falling on certain substances and being dispersively reflected from them. In respect to pure mathematics, Sir John Herschel did more, I believe, than any other man to introduce into Britain the powerful methods and the valuable notation of modern analysis. A remarkable mode of symbolism had freshly appeared, I believe, in the works of Laplace, and possibly of other French mathematicians; it certainly appeared in Fourier, but whether before or after Herschel's work I cannot say. Of Herschel's gigantic work in astronomical observation I need say nothing. Doubtless a careful account of it will be given in the *Proceedings of the Royal Society of London* for the next anniversary meeting.

In the past year, another representative man of British science is gone. Mathematics had no steadier supporter for half a century than De Morgan. His great book on the differential calculus was, for the mathematical student of thirty years ago, a highly-prized repository of all the best things that could be brought together under that title. I do not believe it is less valuable now; and if it is less valued, may this not be because it is too good for examination purposes, and because the modern student, labouring to win marks in the struggle for existence, must not suffer himself to be beguiled from the stern path of duty by any attractive beauties in the subject of his study?

One of the most valuable services to science which the British Association has performed has been the establishment, and the twenty-nine year's maintenance, of its Observatory. The magnificent services which it has rendered to science are so well known that any statement of them which I could attempt on the present occasion would be superfluous. Their value is due in a great measure to the indefatigable zeal and the great ability of two Scotchmen, both from Edinburgh, who successively held the office of Superintendent of the Observatory of the British Association—Mr. Welsh for nine years, until his death in 1859, and Dr. Balfour Stewart from then until the present time. Fruits of their labours are to be found all through our volumes of Reports for these twenty-one years.

The institution now enters on a new stage of its existence. The noble liberality of a private benefactor, one who has laboured for its welfare with self-sacrificing devotion unintermittingly from within a few years of its creation, has given it a permanent independence, under the general management of a Committee of the Royal Society. Mr. Gassiot's gift of £10,000 secures the continuance at Kew of the regular operation of the self-recording instruments for observing the phenomena of terrestrial magnetism and meteorology, without the necessity for further support from the British Association.

The success of the Kew Magnetic and Meteorological Observatory affords an example of the great gain to be earned for science by the foundation of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be, not teaching, but experimenting. Whether we look to the honour of England, as a nation which ought always to be the foremost in promoting physical science, or to those vast economical advantages which must accrue from such establishments, we cannot but feel that experimental research ought to be made with us an object of national concern, and not left, as hitherto, exclusively to the private enterprise of self-sacrificing amateurs, and the necessarily inconsecutive action of our present Governmental Departments and of casual Committees. The Council of the Royal Society of Edinburgh has moved for this object in a memorial presented by them to the Royal Commission on Scientific Education and the Advancement of Science.

The physical laboratories which have grown up in the Universities of Glasgow and Edinburgh, and in Owen's College, Manchester, show the want felt of Colleges of Research; but they go but infinitesimally towards supplying it, being absolutely destitute of means, material or personal, for advancing science except at the expense of volunteers, or securing that volunteers shall be found to continue even such little work as at present is carried on.

The whole of Andrews's splendid work in Queen's College, Belfast, has been done under great difficulties and disadvantages, and at great personal sacrifices; and up to the present time there is not a student's physical laboratory in any one of the Queen's Colleges in Ireland—a want which surely ought not to remain unsupplied. Each of these institutions (the four Scotch Universities, the three Queen's Colleges, and Owen's College, Manchester) requires two professors of Natural Philosophy—one who shall be responsible for the teaching, the other for the advancement of science by experiment. The University of Oxford has already established a physical laboratory. The munificence of its Chancellor is about to supply the University of Cambridge with a splendid laboratory, to be constructed under the eye of Professor Clerk Maxwell. On this subject I shall say no more at present, but simply read a sentence which was spoken by Lord Milton in the first Presidential Address to the British Association, when it met at York in the year 1831:—"In addition to more direct benefits, these meetings [of the British Association], I hope, will be the means of impressing on the Government the conviction that the love of scientific pursuits, and the means of pursuing them, are not confined to the metropolis; and I hope that when the Government is fully impressed with the knowledge of the great desire entertained to promote science in every part of the empire, they will see the necessity of affording it due encouragement, and of giving every proper stimulus to its advancement."

Besides abstracts of papers read, and discussions held, before the Sections, the Annual Reports of the British Association contain a large mass of valuable matter of another class. It was an early practice of the Association, a practice that might well be further developed, to call occasionally for a special report on some particular branch of science from a man eminently qualified for the task. The reports received in compliance with these invitations have all done good service in their time, and they remain permanently useful as landmarks in the history of science. Some of them have led to vast practical results; others of a more abstract character are valuable to this day as powerful and instructive condensations and expositions of the branches of science to which they relate. I cannot better illustrate the two kinds of efficiency realised in this department of the Association's work than by referring to Cayley's Report on Abstract Dynamics* and Sabine's Report on Terrestrial Magnetism† (1838).

In referring to recent advances in several branches of science, I simply choose some of those which have struck me as most notable.

Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results. The popular idea of Newton's grandest discovery is that the theory of gravitation flashed into his mind, and so the discovery was made. It was by a long train of mathematical calculation, founded on results accumulated through prodigious toil of practical astronomers, that Newton first demonstrated the forces urging the planets towards the sun, determined the magnitudes of those forces, and discovered that a force following the same law of variation with distance urges the moon towards the earth. *Then* first, we may suppose, came to him the idea of the universality of gravitation; but when he attempted to compare the magnitude of the force on the moon with the magnitude of the force of gravitation of a heavy body of equal mass at the earth's surface, he did not find the agreement which the law he was discovering required. Not for years after would he publish his discovery as made. It is recounted that, being present at a meeting of the Royal Society, he heard a paper read, describing geodesic measurement by Picard, which led to a serious correction of the previously accepted estimate of the earth's radius. This was what Newton required. He went home with the result, and commenced his calculations, but felt so much agitated that he handed over the arithmetical work to a friend; then (and not when sitting in a garden he saw an apple fall) did he ascertain that gravitation keeps the moon in her orbit.

Faraday's discovery of specific inductive capacity, which inaugurated the new philosophy tending to discard action

* Report on the Recent Progress of Theoretical Dynamics, by A. Cayley (Report of the British Association 1857, p. 1).

† Report on the Variations of the Magnetic Intensity observed at different points of the Earth's Surface, by Major Sabine, F.R.S. (forming part of the 7th Report of the British Association).

at a distance, was the result of minute and accurate measurement of electric forces.

Joule's discovery of thermo-dynamic law through the regions of electro-chemistry, electro-magnetism, and elasticity of gases was based on a delicacy of thermometry which seemed simply impossible to some of the most distinguished chemists of the day.

Andrews's discovery of the continuity between the gaseous and liquid states was worked out by many years of laborious and minute measurement of phenomena scarcely sensible to the naked eye.

Great service has been done to science by the British Association in promoting accurate measurement in various subjects. The origin of exact science in terrestrial magnetism is traceable to Gauss's invention of methods of finding the magnetic intensity in absolute measure. I have spoken of the great work done by the British Association in carrying out the application of this invention in all parts of the world. Gauss's colleague in the German Magnetic Union, Weber, extended the practice of absolute measurement to electric currents, the resistance of an electric conductor, and the electromotive force of a galvanic element. He showed the relation between electrostatic and electro-magnetic units for absolute measurement, and made the beautiful discovery that resistance, in absolute electro-magnetic measure, and the reciprocal of resistance, or, as we call it, "conducting power," in electrostatic measure, are each of them a velocity. He made an elaborate and difficult series of experiments to measure the velocity which is equal to the conducting power, in electrostatic measure, and at the same time to the resistance in electro-magnetic measure, in one and the same conductor. Maxwell, in making the first advance along a road of which Faraday was the pioneer, discovered that this velocity is physically related to the velocity of light, and that, on a certain hypothesis regarding the elastic medium concerned, it may be exactly equal to the velocity of light. Weber's measurement verifies approximately this equality, and stands in science *monumentum ære perennius*, celebrated as having suggested this most grand theory, and as having afforded the first quantitative test of the recondite properties of matter on which the relations between electricity and light depend. A re-measurement of Weber's critical velocity on a new plan by Maxwell himself, and the important correction of the velocity of light by Foucault's laboratory experiments, verified by astronomical observation, seem to show a still closer agreement. The most accurate possible determination of Weber's critical velocity is just now a primary object of the Association's Committee on Electric Measurement; and it is at present premature to speculate as to the closeness of the agreement between that velocity and the velocity of light. This leads me to remark how much science, even in its most lofty speculations, gains in return for benefits conferred by its application to promote the social and material welfare of man. Those who perilled and lost their money in the original Atlantic Telegraph were impelled and supported by a sense of the grandeur of their enterprise, and of the world-wide benefits which must flow from its success; they were at the same time not unmoved by the beauty of the scientific problem directly presented to them; but they little thought that it was to be immediately, through their work, that the scientific world was to be instructed in a long-neglected and discredited fundamental electric discovery of Faraday's, or that, again, when the assistance of the British Association was invoked to supply their electricians with methods for absolute measurement (which they found necessary to secure the best economical return for their expenditure, and to obviate and detect those faults in their electric material which had led to disaster), they were laying the foundation for accurate electric measurement in every scientific laboratory in the world, and initiating a train of investigation which now sends up branches into the loftiest regions and subtlest ether of natural philosophy. Long may the British Association continue a bond of union, and a medium for the interchange of good offices between science and the world!

The greatest achievement yet made in molecular theory of the properties of matter is the Kinetic theory of Gases, shadowed forth by Lucretius, definitely stated by Daniel Bernoulli, largely developed by Herapath, made a reality by Joule, and worked out to its present advanced state by Clausius and Maxwell. Joule, from his dynamical equivalent of heat, and his experiments upon the heat produced by the condensation of gas, was able to estimate the average velocity of the ultimate molecules or atoms composing it. His estimate for hydrogen was 6225 feet per second at temperature 60° F., and 6055 feet per second at the freezing-point. Clausius took fully into account the impacts of molecules on one another, and the kinetic energy of *relative* motions of the matter constituting an individual atom. He investigated the relation between their diameters, the number in a given space, and the mean length of path from impact to impact, and so gave the foundation for estimates of the absolute dimensions of atoms, to which I shall refer later. He explained the slowness of gaseous diffusion by the mutual impacts of the atoms, and laid a secure foundation for a complete theory of the diffusion of fluids, previously a most refractory enigma. The deeply penetrating genius of Maxwell brought in viscosity and thermal conductivity, and thus completed the dynamical explanation of all the known properties of gases, except their electric resistance and brittleness to electric force.

When the theory, of which we have the first instalment in Clausius and Maxwell's work, is complete, we are but brought face to face with a superlatively grand question, What is the inner mechanism of the atom?

In the answer to this question we must find the explanation not only of the atomic elasticity, by which the atom is a chronometric vibrator according to Stokes's discovery, but of chemical affinity and of the differences of quality of different chemical elements, at present a mere mystery in science. Helmholtz's exquisite theory of vortex-motion in an incompressible frictionless liquid has been suggested as a finger-post, pointing a way which may possibly lead to a full understanding of the properties of atoms, carrying out the grand conception of Lucretius, who "admits no subtle ethers, no variety of elements with fiery, or watery, or light, or heavy principles; nor supposes light to be one thing, fire another, electricity a fluid, magnetism a vital principle, but treats all phenomena as mere properties or accidents of simple matter." This statement I take from an admirable paper on the atomic theory of Lucretius, which appeared in the *North British Review* for March, 1868, containing a most interesting and instructive summary of ancient and modern doctrine regarding atoms. Allow me to read from that article one other short passage finely describing the present aspect of atomic theory:—"The existence of the chemical atom, already quite a complex little world, seems very probable; and the description of the Lucretian atom is wonderfully applicable to it. We are not wholly without hope that the real weight of each such atom may some day be known—not merely the relative weight of the several atoms, but the number in a given volume of any material; that the form and motion of the parts of each atom and the distances by which they are separated may be calculated: that the motions by which they produce heat, electricity, and light may be illustrated by exact geometrical diagrams; and that the fundamental properties of the intermediate and possibly constituent medium may be arrived at. Then the motion of planets and music of the spheres will be neglected for a while in admiration of the maze in which the tiny atoms run."

Even before this was written some of the anticipated results had been partially attained. Loschmidt in Vienna had shown, and not much later Stoney independently in England showed, how to deduce from Clausius and Maxwell's kinetic theory of gases a superior limit to the number of atoms in a given measurable space. I was unfor-

tunately quite unaware of what Loschmidt and Stoney had done when I made a similar estimate on the same foundation, and communicated it to *Nature* in an article on "The Size of Atoms." But questions of personal priority, however interesting they may be to the persons concerned, sink into insignificance in the prospect of any gain of deeper insight into the secrets of nature. The triple coincidence of independent reasoning in this case is valuable as confirmation of a conclusion violently contravening ideas and opinions which had been almost universally held regarding the dimensions of the molecular structure of matter. Chemists and other naturalists had been in the habit of evading questions as to the hardness or indivisibility of atoms by virtually assuming them to be infinitely small and infinitely numerous. We must now no longer look upon the atom, with Boscovich, as a mystic point endowed with inertia and the attribute of attracting or repelling other such centres with forces depending upon the intervening distances (a supposition only tolerated with the tacit assumption that the inertia and attraction of each atom is infinitely small and the number of atoms infinitely great), nor can we agree with those who have attributed to the atom occupation of space with infinite hardness and strength (incredible in any finite body); but we must realise it as a piece of matter of measurable dimensions, with shape, motion, and laws of action, intelligible subjects of scientific investigation.

The prismatic analysis of light discovered by Newton was estimated by himself as being "the oddest, if not the most considerable, detection which "hath hitherto been made in the operations of nature."

Had he not been deflected from the subject, he could not have failed to obtain a pure spectrum; but this, with the inevitably consequent discovery of the dark lines, was reserved for the nineteenth century. Our fundamental knowledge of the dark lines is due solely to Fraunhofer. Wollaston saw them, but did not discover them. Brewster laboured long and well to perfect the prismatic analysis of sunlight; and his observations on the dark bands produced by the absorption of interposed gases and vapours laid important foundations for the grand superstructure which he scarcely lived to see. Piazzi Smyth, by spectroscopic observation performed on the Peak of Teneriffe, added greatly to our knowledge of the dark lines produced in the solar spectrum by the absorption of our own atmosphere. The prism became an instrument for chemical qualitative analysis in the hands of Fox Talbot and Herschel, who first showed how, through it, the old "blowpipe test" or generally the estimation of substances from the colours which they give to flames, can be prosecuted with an accuracy and a discriminating power not to be attained when the colour is judged by the unaided eye. But the application of this test to solar and stellar chemistry had never, I believe, been suggested, either directly or indirectly, by any other naturalist, when Stokes taught it to me in Cambridge at some time prior to the summer of 1852. The observational and experimental foundations on which he built were:—

(1). The discovery by Fraunhofer of a coincidence between his double dark line D, of the solar spectrum and a double bright line which he observed in the spectra of ordinary artificial flames.

(2). A very rigorous experimental test of this coincidence by Professor W. H. Miller, which showed it to be accurate to an astonishing degree of minuteness.

(3). The fact that the yellow light given out when salt is thrown on burning spirit consists almost solely of the two nearly identical qualities which constitute that double bright line.

(4). Observations made by Stokes himself, which showed the bright line, D, to be absent in a candle-flame when the wick was snuffed clean, so as not to project into the luminous envelope, and from an alcohol flame when the spirit was burned in a watch-glass. And

(5). Foucault's admirable discovery (*L'Institut*, Feb. 7, 1849) that the voltaic arc between charcoal points is "a medium which emits the rays D on its own account, and at the same time absorbs them when they come from another quarter."

The conclusions, theoretical and practical, which Stokes taught me, and which I gave regularly afterwards in my public lectures in the University of Glasgow, were:—

(1). That the double line D, whether bright or dark, is due to vapour of sodium.

(2). That the ultimate atom of sodium is susceptible of regular elastic vibrations, like those of a tuning-fork or of stringed musical instruments; that like an instrument with two strings tuned to approximate unison, or an approximately circular elastic disk, it has two fundamental notes or vibrations of approximately equal pitch; and that the periods of these vibrations are precisely the periods of the two slightly different yellow lights constituting the double bright line D.

(3). That when vapour of sodium is at a high enough temperature to become itself a source of light, each atom executes these two fundamental vibrations simultaneously; and that, therefore, the light proceeding from it is of the two qualities constituting the double bright line D.

(4). That when vapour of sodium is present in space across which light from another source is propagated, its atoms, according to a well-known general principle of dynamics, are set to vibrate in either or both of those fundamental modes, if some of the incident light is of one or other of their periods, or some of one and some of the other; so that the energy of the waves of those particular qualities of light is converted into thermal vibrations of the medium and dispersed in all directions, while light of all other qualities, even though very nearly agreeing with them, is transmitted with comparatively no loss.

(5). That Fraunhofer's double dark line D of solar and stellar spectra is due to the presence of vapour of sodium in atmospheres surrounding the sun and those stars in whose spectra it had been observed.

(6). That other vapours than sodium are to be found in the atmospheres of sun and stars by searching for substances producing in the spectra of artificial flames bright lines coinciding with other dark lines of the solar and stellar spectra than the Fraunhofer line D.

The last of these propositions I felt to be confirmed (it was, perhaps, partly suggested) by a striking and beautiful experiment admirably adapted for lecture illustrations, due to Foucault, which had been shown to me by M. Duboscque Soleil, and the Abbé Moigno, in Paris in the month of October, 1850. A prism and lenses were arranged to throw upon a screen an approximately pure spectrum of a vertical electric arc between charcoal poles of a powerful battery, the lower one of which was hollowed like a cup. When pieces of copper and pieces of zinc were separately thrown into the cup, the spectrum exhibited, in perfectly definite positions, magnificent well-marked bands of different colours characteristic of the two metals. When a piece of brass, compounded of copper and zinc, was put into the cup, the spectrum showed all the bands, each precisely in the place in which it had been seen when one metal or the other had been used separately.

It it much to be regretted that this great generalisation was not published to the world twenty years ago. I say this, not because it is to be regretted that Ångström should have the credit of having in 1853 published independently the statement that "an incandescent gas emits "luminous rays of the same refrangibility as those which it can absorb;" or that Balfour Stewart should have been unassisted by it when, coming to the subject from a very different point of view, he made, in his extension of the "Theory of Exchanges,"* the still wider generalisation that the radiating power of every kind of substance is equal to its absorbing power for every kind of ray; or that Kirchhoff also should have in 1859 independently discovered the same proposition, and shown its application to solar and stellar chemistry; but because we might now

* *Edin. Transactions*, 1858-59.

be in possession of the inconceivable riches of astronomical results which we expect from the next ten years' investigation by spectrum analysis, had Stokes given his theory to the world when it first occurred to him.

To Kirchhoff belongs, I believe, solely the great credit of having first actually sought for and found other metals than sodium in the sun by the method of spectrum analysis. His publication of October, 1859, inaugurated the practice of solar and stellar chemistry, and gave spectrum analysis an impulse to which, in a great measure, is due its splendidly successful cultivation by the labours of many able investigators within the last ten years.

Plücker and Hittorf opened ground in advancing the physics of spectrum analysis and made the important discovery of changes in the spectra of ignited gases produced by changes in the physical condition of the gas. The scientific value of the meetings of the British Association is well illustrated by the fact that it was through conversation with Plücker at the Newcastle meeting that Lockyer was first led into the investigation of the effects of varied pressure on the quality of the light emitted by glowing gas which he and Frankland have prosecuted with such admirable success. Scientific wealth tends to accumulation according to the law of compound interest. Every addition to knowledge of properties of matter supplies the naturalist with new instrumental means for discovering and interpreting phenomena of nature, which, in their turn, afford foundations for fresh generalisations, bringing gains of permanent value into the great storehouse of philosophy. Thus Frankland, led, from observing the want of brightness of a candle burning in a tent on the summit of Mont Blanc, to scrutinise Davy's theory of flame, discovered that brightness without incandescent solid particles is given to a purely gaseous flame by augmented pressure, and that a dense ignited gas gives a spectrum comparable with that of the light from an incandescent solid or liquid. Lockyer joined him; and the two found that every incandescent substance gives a continuous spectrum—that an incandescent gas under varied pressure gives bright bars across the continuous spectrum, some of which, from the sharp, hard, and fast lines observed where the gas is in a state of extreme attenuation, broaden out on each side into nebulous bands as the density is increased, and are ultimately lost in the continuous spectrum when the condensation is pushed on till the gas becomes a fluid no longer to be called gaseous. More recently they have examined the influence of temperature, and have obtained results which seem to show that a highly attenuated gas, which at a high temperature gives several bright lines, gives a smaller and smaller number of lines, of sufficient brightness to be visible, when the temperature is lowered, the density being kept unchanged. I cannot refrain here from remarking how admirably this beautiful investigation harmonises with Andrews's great discovery of continuity between the gaseous and liquid states. Such things make the life-blood of science. In contemplating them we feel as if led out from narrow waters of scholastic dogma to a refreshing excursion on the broad and deep ocean of truth, where we learn from the wonders we see that there are endlessly more and more glorious wonders still unseen.

Stokes's dynamical theory supplies the key to the philosophy of Frankland and Lockyer's discovery. Any atom of gas, when struck and left to itself, vibrates with perfect purity its fundamental note or notes. In a highly attenuated gas each atom is very rarely in collision with other atoms, and therefore is nearly at all times in a state of true vibration. Hence the spectrum of a highly attenuated gas consists of one or more perfectly sharp bright lines, with a scarcely perceptible continuous gradation of prismatic colour. In denser gas, each atom is frequently in collision, but still is for much more time free, in intervals between collisions, than engaged in collision; so that not only is the atom itself thrown sensibly out of tune during a sensible proportion of its whole time, but the confused jangle of vibrations in every variety of period during the actual collision becomes more considerable in its influence. Hence, bright lines in the spectrum broaden out somewhat, and the continuous spectrum becomes less faint. In still denser gas, each atom may be almost as much time in collision as free, and the spectrum then consists of broad nebulous bands crossing a continuous spectrum of considerable brightness. When the medium is so dense that each atom is always in collision, that is to say, never free from influence of its neighbours, the spectrum will generally be continuous, and may present little or no appearance of bands, or even of maxima of brightness. In this condition the fluid can be no longer regarded as a gas, and we must judge of its relation to the vaporous or liquid states according to the critical conditions discovered by Andrews.

While these great investigations of properties of matter were going on, naturalists were not idle with the newly-recognised power of the spectroscope at their service. Chemists soon followed the example of Bunsen, in discovering new metals in terrestrial matter by the old blowpipe and prism test of Fox Talbot and Herschel. Biologists applied spectrum analysis to animal and vegetable chemistry, and to sanitary investigations. But it is in astronomy that spectroscopic research has been carried on with the greatest activity, and been most richly rewarded with results. The chemist and the astronomer have joined their forces. An astronomical observatory has now appended to it a stock of reagents such as hitherto was only to be found in the chemical laboratory. A devoted corps of volunteers of all nations, whose motto might well be *ubique*, have directed their artillery to every region of the universe. The sun, the spots on his surface, the corona, and the red and yellow prominences seen round him during total eclipses, the moon, the planets, comets, auroras, nebulæ, white stars, yellow stars, red stars, variable and temporary stars, each tested by the prism, was compelled to show its distinguishing prismatic colours. Rarely before in the history of science has enthusiastic perseverance, directed by penetrative genius, produced within ten years so brilliant a succession of discoveries. It is not merely the *chemistry* of sun and stars, as first suggested, that is subjected to analysis by the spectroscope. Their whole laws of being are now subjects of direct investigation; and already we have glimpses of their evolutional history through the stupendous power of this most subtle and delicate test. We had only solar and stellar chemistry; we now have solar and stellar physiology.

It is an old idea that the colour of a star may be influenced by its motion relatively to the eye of the spectator, so as to be tinged with red if it moves from the earth, or blue if it moves towards the earth. William Allen Miller, Huggins, and Maxwell showed how, by aid of the spectroscope, this idea may be made the foundation of a method of measuring the relative velocity with which a star approaches to, or recedes from, the earth. The principle is, first to identify, if possible, one or more of the lines in the spectrum of the star, with a line or lines in the spectrum of sodium, or some other terrestrial substance, and then (by observing the star and the artificial light simultaneously by the same spectroscope) to find the difference, if any, between their refrangibilities. From this difference of refrangibility the ratio of the periods of the two lights is calculated, according to data determined by Fraunhofer from comparisons between the positions of the dark lines in the prismatic spectrum and in his own "interference spectrum" (produced by substituting for the prism a fine grating). A first comparatively rough application of the test by Miller and Huggins to a large number of the principal stars of our skies, including Aldebaran, α Orionis, β Pegasi, Sirius, α Lyræ, Capella, Arcturus, Pollux, Castor (which they had observed rather for the chemical purpose than for this), proved that not one of them had so great a velocity as 315 kilometres per second to or from the earth, which is a *most momentous result in respect to cosmical dynamics*. Afterwards, Huggins made

special observations of the velocity test, and succeeded in making the measurement in one case, that of Sirius, which he then found to be receding from the earth at the rate of 66 kilometres per second. This, corrected for the velocity of the earth at the time of the observation, gave a velocity of Sirius, relatively to the sun, amounting to 47 kilometres per second. The minuteness of the difference to be measured, and the smallness of the amount of light, even when the brightest star is observed, renders the observation extremely difficult. Still, with such great skill as Mr. Huggins has brought to bear on the investigation, it can scarcely be doubted that velocities of many other stars may be measured. What is now wanted is, certainly not greater skill, perhaps not even more powerful instruments, but *more instruments and more observers*. Lockyer's applications of the velocity test to the relative motions of different gases in the sun's photosphere, spots, chromosphere, and chromospheric prominences, and his observations of the varying spectra presented by the same substance as it moves from one position to another in the sun's atmosphere, and his interpretations of these observations, according to the laboratory results of Frankland and himself, go far towards confirming the conviction that in a few years all the marvels of the sun will be dynamically explained according to known properties of matter.

During six or eight precious minutes of time, spectroscopes have been applied to the solar atmosphere and to the corona seen round the dark disc of the moon eclipsing the sun. Some of the wonderful results of such observations, made in India on the occasion of the eclipse of August, 1868, were described by Professor Stokes in a previous address. Valuable results have, through the liberal assistance given by the British and American Governments, been obtained also from the total eclipse of last December, notwithstanding a generally unfavourable condition of weather. It seems to have been proved that at least some sensible part of the light of the "corona" is a terrestrial atmospheric halo or dispersive reflection of the light of the glowing hydrogen and "helium"* round the sun. I believe I may say, on the present occasion, when preparation must again be made to utilise a total eclipse of the sun, that the British Association confidently trusts to our Government exercising the same wise liberality as heretofore in the interests of science.

For a few years Mayer's theory of solar heat had seemed to me probable; but I had been led to regard it as no longer tenable, because I had been in the first place driven, by consideration of the very approximate constancy of the earth's period of revolution round the sun for the last 2000 years, to conclude that "The principal source, perhaps the sole appreciably effective source, of sun-heat, is in bodies circulating round the sun at present inside the earth's orbit;"† and because Le Verrier's researches on the motion of the planet Mercury, though giving evidence of a sensible influence attributable to matter circulating as a great number of small planets within his orbit round the sun, showed that the amount of matter that could possibly be assumed to circulate at any considerable distance from the sun must be very small; and therefore "if the meteoric influx taking place at present is enough to produce any appreciable portion of the heat radiated away, it must be supposed to be from matter circulating round the sun, within very short distances of his surface. The density of this meteoric cloud would have to be supposed so great that comets could scarcely have escaped as comets actually have escaped, showing no discoverable effects of resistance, after passing his surface within a distance equal to one-eighth of his radius. All things considered, there seems little probability in the hypothesis that solar radiation is compensated to any appreciable degree, by heat generated by meteors falling in, at present; and, as it can be shown that no chemical theory is tenable,* it must be concluded as most probable that the sun is at present merely an incandescent liquid mass cooling."†

Thus, on purely astronomical grounds, was I long ago led to abandon as very improbable the hypothesis that the sun's heat is supplied dynamically from year to year by the influx of meteors. But now spectrum analysis gives proof finally conclusive against it.

Each meteor circulating round the sun must fall in along a very gradual spiral path, and before reaching the sun must have been for a long time exposed to an enormous heating effect from his radiation when very near, and must thus have been driven into vapour before actually falling into the sun. Thus, if Mayer's hypothesis is correct, friction between vortices of meteoric vapours and the sun's atmosphere must be the immediate cause of solar heat; and the velocity with which these vapours circulate round equatorial parts of the sun must amount to 435 kilometres per second. The spectrum test of velocity applied by Lockyer showed but a twentieth part of this amount as the greatest observed relative velocity between different vapours in the sun's atmosphere.

At the first Liverpool meeting of the British Association (1854), in advancing a gravitational theory to account for all the heat, light, and motions of the universe, I urged that the immediately antecedent condition of the matter of which the sun and planets were formed, not being fiery, could not have been gaseous; but that it probably was solid, and may have been like the meteoric stones which we still so frequently meet with through space. The discovery of Huggins, that the light of the nebulæ, so far as hitherto sensible to us, proceeds from incandescent hydrogen and nitrogen gases, and that the heads of comets also give us light of incandescent gas, seems at first sight literally to fulfil that part of the Nebular hypothesis to which I had objected. But a solution, which seems to me in the highest degree probable, has been suggested by Tait. He supposes that it may be by ignited gaseous exhalations proceeding from the collision of meteoric stones that nebulæ and the heads of comets show themselves to us, and he suggested, at a former meeting of the Association, that experiments should be made for the purpose of applying spectrum analysis to the light which has been observed in gunnery trials, such as those at Shoeburyness, when iron strikes against iron at a great velocity, but varied by substituting for the iron various solid materials, metallic or stony. Hitherto this suggestion has not been acted upon; but surely it is one the carrying out of which ought to be promoted by the British Association.

Most important steps have been recently made towards the discovery of the nature of comets; establishing with nothing short of certainty the truth of a hypothesis which had long appeared to me probable—that they consist of groups of meteoric stones;—accounting satisfactorily for the light of the nucleus; and giving a simple and rational explanation of phenomena presented by the tails of comets which had been regarded by the greatest astronomers as almost preternaturally marvellous. The meteoric hypothesis to which I have referred remained a mere hypothesis (I do not know that it was even ever published), until, in 1866, Schiaparelli calculated, from observations on the August meteors, an orbit for these bodies which he found to agree almost perfectly with the orbit of the great comet of 1862 as calculated by Oppolzer; and so discovered and demonstrated that a comet consists of a group of meteoric stones. Professor Newton, of Yale College, United States, by examining ancient records, ascertained that in periods of about thirty-three years, since the year 902, there have been exceptionally brilliant displays of the November meteors. It had long been believed that these interesting visitants came from a train

* Frankland and Lockyer find the yellow prominences to give a very decided bright line not far from D, but hitherto not identified with any terrestrial flame. It seems to indicate a new substance, which they propose to call Helium.

† "On the Mechanical Energies of the Solar System." *Transactions of the Royal Society of Edinburgh*, 1854; and *Phil. Mag.*, 1854, second half year.

* "Mechanical Energies," &c.

† "Age of the Sun's Heat," *Macmillan's Magazine*, March, 1862.

of small detached planets circulating round the sun all in nearly the same orbit, and constituting a belt analogous to Saturn's ring, and that the reason for the comparatively large number of meteors which we observe annually about the 14th of November is, that at that time the earth's orbit cuts through the supposed meteoric belt. Professor Newton concluded from his investigation that there is a denser part of the group of meteors which extends over a portion of the orbit so great as to occupy about one-tenth or one-fifteenth of the periodic time in passing any particular point, and gave a choice of five different periods for the revolution of this meteoric stream round the sun, any one of which would satisfy his statistical result. He further concluded that the line of nodes, that is to say, the line in which the plane of the meteoric belt cuts the plane of the earth's orbit, has a progressive sidereal motion of about 52·4″ per annum. Here, then, was a splendid problem for the physical astronomer; and, happily, one well qualified for the task took it up. Adams, by the application of a beautiful method invented by Gauss, found that of the five periods allowed by Newton just one permitted the motion of the line of nodes to be explained by the disturbing influence of Jupiter, Saturn, and other planets. The period chosen on these grounds is 33¼ years. The investigation showed further that the form of the orbit is a long ellipse, giving for shortest distance from the sun 145 million kilometres, and for longest distance 2895 million kilometres. Adams also worked out the longitude of the perihelion and the inclination of the orbit's plane to the plane of the ecliptic. The orbit which he thus found agreed so closely with that of Temple's Comet I. 1866 that he was able to identify the comet and the meteoric belt. The same conclusion had been pointed out a few weeks earlier by Schiaparelli, from calculations by himself on data supplied by direct observations on the meteors, and independently by Peters from calculations by Le Verrier on the same foundation. It is therefore thoroughly established that Temple's Comet I. 1866 consists of an elliptic train of minute planets, of which a few thousands or millions fall to the earth annually about the 14th of November, when we cross their track. We have probably not yet passed through the very nucleus or densest part; but thirteen times, in Octobers and Novembers, from October 13, A.D. 902 to November 14, 1866, inclusive (this last time having been correctly predicted by Prof. Newton), we have passed through a part of the belt greatly denser than the average. The densest part of the train, when near enough to us, is visible as the head of the comet. This astounding result, taken along with Huggins's spectroscopic observations on the light of the heads and tails of comets, confirm most strikingly Tait's theory of comets, to which I have already referred; according to which the comet, a group of meteoric stones, is self-luminous in its nucleus, on account of collisions among its constituents, while its "tail" is merely a portion of the less dense part of the train illuminated by sunlight, and visible or invisible to us according to circumstances, not only of density, degree of illumination, and nearness, but also of tactic arrangement, as of a flock of birds or the edge of a cloud of tobacco smoke!

The essence of science, as is well illustrated by astronomy and cosmical physics, consists in inferring antecedent conditions, and anticipating future evolutions, from phenomena which have actually come under observation. In biology the difficulties of successfully acting up to this ideal are prodigious. The earnest naturalists of the present day are, however, not appalled or paralysed by them, and are struggling boldly and laboriously to pass out of the mere "Natural History stage" of their study, and bring zoology within the range of Natural Philosophy. A very ancient speculation, still clung to by many naturalists (so much so that I have a choice of modern terms to quote in expressing it), supposes that, under meteorological conditions very different from the present, dead matter may have run together or crystallised or fermented into "germs of life," or "organic cells," or "protoplasm." But science brings a vast mass of inductive evidence against this hypothesis of spontaneous generation, as you have heard from my predecessor in the Presidential chair. Careful enough scrutiny has, in every case up to the present day, discovered life as antecedent to life. Dead matter cannot become living without coming under the influence of matter previously alive. This seems to me as sure a teaching of science as the law of gravitation. I utterly repudiate, as opposed to all philosophical uniformitarianism, the assumption of "different meteorological conditions"—that is to say, somewhat different vicissitudes of temperature, pressure, moisture, gaseous atmosphere—to produce or to permit that to take place by force or motion of dead matter alone, which is a direct contravention of what seems to us biological law. I am prepared for the answer, "Our code of biological law is an expression of our ignorance as well as of our knowledge." And I say "Yes; search for spontaneous generation out of inorganic materials; let any one not satisfied with the purely negative testimony of which we have now so much against it, throw himself into the inquiry." Such investigations as those of Pasteur, Pouchet, and Bastian are among the most interesting and momentous in the whole range of Natural History, and their results, whether positive or negative, must richly reward the most careful and laborious experimenting. I confess to being deeply impressed by the evidence put before us by Professor Huxley, and I am ready to adopt, as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life.

How, then, did life originate on the earth? Tracing the physical history of the earth backwards, on strict dynamical principles, we are brought to a red-hot melted globe on which no life could exist. Hence when the earth was first fit for life, there was no living thing on it. There were rocks solid and disintegrated, water, air all round, warmed and illuminated by a brilliant sun, ready to become a garden. Did grass and trees and flowers spring into existence, in all the fulness of ripe beauty, by a fiat of creative power? or did vegetation, growing up from seed sown, spread and multiply over the whole earth? Science is bound, by the everlasting law of honour, to face fearlessly every problem which can fairly be presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not invoke an abnormal act of creative power. When a lava stream flows down the sides of Vesuvius or Etna it quickly cools and becomes solid; and after a few weeks or years it teems with vegetable and animal life, which for it originated by the transport of seed and ova and by the migration of individual living creatures. When a volcanic island springs up from the sea, and after a few years is found clothed with vegetation, we do not hesitate to assume that seed has been wafted to it through the air, or floated to it on rafts. Is it not possible, and if possible, is it not probable, that the beginning of vegetable life on the earth is to be similarly explained? Every year thousands, probably millions, of fragments of solid matter fall upon the earth—whence came these fragments? What is the previous history of any one of them? Was it created in the beginning of time an amorphous mass? This idea is so unacceptable that, tacitly or explicitly, all men discard it. It is often assumed that all, and it is certain that some, meteoric stones are fragments which had been broken off from greater masses and launched free into space. It is as sure that collisions must occur between great masses moving through space as it is that ships, steered without intelligence directed to prevent collision, could not cross and re-cross the Atlantic for thousands of years with immunity from collisions. When two great masses come into collision in space it is certain that a large part of each is melted; but it seems also quite certain that in many cases a large quantity of débris must be shot forth in all directions, much of which may have

experienced no greater violence than individual pieces of rock experience in a land-slip or in blasting by gunpowder. Should the time when this earth comes into collision with another body, comparable in dimensions to itself, be when it is still clothed as at present with vegetation, many great and small fragments carrying seed and living plants and animals would undoubtedly be scattered through space. Hence and because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instant no life existed upon this earth, one such stone falling upon it might, by what we blindly call *natural* causes, lead to its becoming covered with vegetation. I am fully conscious of the many scientific objections which may be urged against this hypothesis, but I believe them to be all answerable. I have already taxed your patience too severely to allow me to think of discussing any of them on the present occasion. The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific.

From the earth stocked with such vegetation as it could receive meteorically, to the earth teeming with all the endless variety of plants and animals which now inhabit it, the step is prodigious; yet, according to the doctrine of continuity, most ably laid before the Association by a predecessor in this chair (Mr. Grove), all creatures now living on earth have proceeded by orderly evolution from some such origin. Darwin concludes his great work on "The Origin of Species" with the following words:—"It is interesting to contemplate an entangled bank clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. . . . . There is grandeur in this view of life with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful and most wonderful, have been and are being evolved." With the feeling expressed in these two sentences I most cordially sympathise. I have omitted two sentences which come between them, describing briefly the hypothesis of "the origin of species by natural selection," because I have always felt that this hypothesis does not contain the true theory of evolution, if evolution there has been, in biology. Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution, with, however, some reservation in respect to the origin of man, objected to the doctrine of natural selection, that it was too like the Laputan method of making books, and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism. I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations. Reaction against the frivolities of teleology, such as are to be found, not rarely, in the notes of the learned commentators on Paley's "Natural Theology," has, I believe, had a temporary effect in turning attention from the solid and irrefragable argument so well put forward in that excellent old book. But overpoweringly strong proofs of intelligent and benevolent design lie all around us; and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us, through nature, the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

Section B.

ADDRESS
TO THE
CHEMICAL SECTION.

AUGUST 3, 1871.

By Dr. ANDREWS, F.R.S.

GENTLEMEN,—

Amidst the vicissitudes to which scientific theories are liable, it was scarcely to be expected that the discarded theory of phlogiston should be resuscitated in our day, and connected with one of the most important generalisations of modern science. The phlogistic theory, elaborated nearly two hundred years ago by Beccher and Stahl, was not, it now appears, wholly founded in error; on the contrary, it was an imperfect anticipation of the great principle of energy, which plays so important a part in physical and chemical changes. The disciple of phlogiston, ignorant of the whole history of chemical combination, connected, it is true, his phlogiston with one only of the combining bodies, instead of recognising that it is eliminated by the union of all. "There can be no doubt," says Dr. Crum Brown, who first suggested this view, "that potential energy is what the chemists of the 17th century meant when they spoke of phlogiston." "Phlogiston and latent heat," playfully remarks Volhard, "which formerly opposed each other in so hot a combat, have entered into a peaceful compact, and, to banish all recollection of their former strife, have assumed in common the new name of energy." But, as Dr. Odling well remarks, "in interpreting the phlogistic writings by the light of modern doctrine, we are not to attribute to their authors the precise notion of energy which now prevails. It is only contended that the phlogistians had, in their time, possession of a real truth in nature, which altogether lost sight of in the intermediate period has since crystallised out in a definite form."

But, whatever may be the true value of the Stahlian views, there can be no doubt that the discoveries which have shed so bright a lustre round the name of Black mark an epoch in the history of science, and gave a mighty impulse to human progress. A recent attempt to ignore the labours of Black and his great contemporaries, and to attribute the foundation of modern chemistry to Lavoisier alone, has already been amply refuted in an able inaugural address, delivered a short time ago from the chair formerly occupied by Black. The statements of Dr. Crum Brown may, indeed, be confirmed on the authority of Lavoisier himself. Through the kindness of Dr. Black's representatives, I have been permitted to examine his correspondence, which has been carefully preserved, and I have been so fortunate as to find in it three original letters from Lavoisier to Dr. Black. They were written in 1789 and 1790, and they appear to comprise the whole of the correspondence on the part of Lavoisier which passed between those distinguished men. Some extracts from these letters were published soon after Dr. Black's death by his friends, Dr. Adam Ferguson and Dr. Robison, but the letters themselves, as far as I know, have never appeared in an entire form; I will crave permission to have them printed as an appendix to this address. Lavoisier, it will be seen, addresses Black as one whom he was accustomed to regard as his master, and whose discoveries had produced important revolutions in science. It may, indeed, be said with truth that Lavoisier completed the foundation on which the grand structure of modern chemistry has since arisen; but Black, Priestley, Scheele, and Cavendish were before Lavoisier, and their claims to a share in the great work are not inferior to those of the illustrious French chemist.

Among the questions of general chemistry, few are

more interesting, or have of late attracted more attention, than the relations which subsist between the chemical composition and refractive power of bodies for light. Newton, it will be remembered, pointed out the distinction between the refractive power of a medium and its refractive index, and gave for the former the expression—

$$\frac{\mu_2 - 1}{d},$$

where μ is the refractive index and d the density of the refracting medium. Sir J. Herschel, anticipating later observations, remarked, in 1830, that Newton's function only expresses the intrinsic refractive power on the supposition of matter being infinitely divisible, but that, if material bodies consist of a finite number of atoms, differing in weight for different substances, the intrinsic refractive power of the atoms of any given medium will be the product of the above function by the atomic weight. The same remark has since been made by Bertholet. Later observations have led to an important modification in the form of Newton's function. Beer showed that the experiments of Biot and Arago, as well as those of Dulong, on the refractive power of gases, agree quite as well with a simpler expression as with that given by Newton; and Gladstone and Dale proposed, in 1863, the formula—

$$\frac{\mu - 1}{d}$$

as expressing more accurately than any other, the results of their experiments on the refractive power of liquids. The researches of Landolt and Wüllner have fully confirmed the general accuracy of the new formula. An important observation, made about twenty years ago by Delffs, has been the starting-point for all subsequent investigations on this subject. Delffs remarked that the refractive indices of the compound ethers increase with the atomic weight, and that isomeric ethers have the same refractive indices. The later researches of Gladstone and of Landolt have, on the whole, confirmed these observations, and have shown that the specific refractive power depends chiefly on the atomic composition of the body, and is little influenced by the mode of grouping of the atoms. These inquiries have gone further, and have led to the discovery of the refraction equivalents of the elements. By comparing the refractive power of compound bodies differing from one another by one or more atoms of the same element, Landolt succeeded in obtaining numbers which express the refraction equivalents of carbon, hydrogen, and oxygen, and corresponding numbers have been obtained for other elements by Gladstone and Haagen. The whole subject has been recently discussed and enriched with many new observations in an able memoir by Gladstone. As might be expected in so novel and recondite a subject, some anomalies occur which are difficult to explain. Thus hydrogen appears in different classes of compounds with at least two refraction equivalents, one three times as great as the other, and the refraction equivalents of the aromatic compounds and their derivatives, as given by observation, are in general higher than the calculated numbers.

A happy modification of the ice calorimeter has been made by Bunsen. The principle of the method—to use, as a measure of heat, the change of volume which ice undergoes in melting—had already occurred to Herschel, and, as it now appears, still earlier to Hermann; but their observations had been entirely overlooked by physicists, and had led to no practical result. Bunsen has, indeed, clearly pointed out that the success of the method depends upon an important condition which is entirely his own, The ice to be melted must be prepared with water free from air, and must surround the source of heat in the form of a solid cylinder, frozen artificially *in situ*. Those who have worked on the subject of heat know how difficult it is to measure absolute quantities with certainty, even where relative results of great accuracy may be attained. The ice calorimeter of Bunsen will therefore be welcomed as an important addition to our means of research. Bunsen has applied his method to determine the specific heats of ruthenium, calcium, and indium, and finds that the atomic weight of indium must be increased by one-half in order to bring it into conformity with the law of Dulong and Petit. He has also made a new determination of the density of ice, which he finds to be 0·9167.

In a Report on the Heat of Combination which was made to this Association in 1849, the existence of a group of isothermal bases was pointed out. "As some of the bases—potash, soda, baryta, strontia—" it was remarked "form what we may, perhaps, designate an isothermal group, such bases will develope the same, or nearly the same, heat in combining with an acid, and no heat will be disengaged during their mutual displacements." The latest experiments of Thomsen have given a remarkable extension to this group of isothermal bases. He finds that the hydrates of lithium, thallium, calcium, and magnesium produce, when all corrections are made, the same amount of heat, on being neutralised by sulphuric acid, as the four bases before mentioned. The hydrate of tetra-methyl-ammonium belongs to the same class of bases. Æthylamin, on the other hand, agrees with ammonia, which, as has been long known, gives out less heat in combining with the acids than potash or soda. An elaborate investigation of the amount of heat evolved in the combustion of coal of different kinds has been made by Scheurer-Kestner and Meunier, accompanied by analyses of the coal. Coal rich in carbon and hydrogen disengages more heat in burning than coal in which those elements are partially replaced by oxygen. After deducting the cinders, the heat produced by the combustion of 1 grm. of coal varied from 8215 to 9622 units.

Tyndall has given an extended account of his experiments on the action of a beam of strong light on certain vapours. He finds that there is a marked difference in the absorbing power of different vapours for the actinic rays. Thus the nitrite of amyl in the state of vapour absorbs rapidly the rays of light competent to decompose it, while iodide of allyl in the same state allows them freely to pass. Morren has continued these experiments in the South of France, and among other results he finds that sulphurous acid is decomposed by the solar beam.

Roscoe has prosecuted the photo-chemical investigations which Bunsen and he began some years ago. For altitudes above 10° the relation between the sun's altitude and the chemical intensity of light is represented by a straight line. Till the sun has reached an altitude of about 20°, the chemical action produced by diffused daylight exceeds that of the direct sun-light; the two actions are then balanced; and at higher elevations the direct sun-light is superior to the diffused light. The supposed inferiority of the chemical action of light under a tropical sun to its action in higher latitudes proves to be a mistake. According to Roscoe and Thorpe, the chemical intensity of light at Para under the equator in the month of April is more than three times greater than at Kew in the month of August.

Hunter has given a great extension to the earlier experiments of Saussure on the absorptive power of charcoal for gases. Cocoa-nut charcoal, according to Hunter's experiments, exceeds all other varieties of wood-charcoal in absorptive power, taking up, at ordinary pressure, 170 volumes of ammonia, and 69 of carbonic acid. Methylic alcohol is more largely absorbed than any other vapour at temperatures from 90° to 127°; but, at 159°, the absorption of ordinary alcohol exceeds it. Cocoa-nut charcoal absorbs 44 times its volume of the vapour of water at 127°. The absorptive power is increased by pressure.

Last year two new processes for improving the manufacture of chlorine attracted the attention of the section, one of these has already proved to be a success, and I am glad to be able to state that Mr. Deacon has recently overcome certain difficulties in his method, and has obtained

a complete absorption of the chlorine. May we hope to see oxygen prepared by a cheap and continuous process from atmospheric air? With baryta the problem can be solved very perfectly, if not economically. Another process is that of Tessié de Mothay, in which the manganate of potassium is decomposed by a current of superheated steam and afterwards revived by being heated in a current of air. A company has lately been formed in New York to apply this process to the production of a brilliant house light. A compound Argand burner is used having a double row of apertures,—the inner row is supplied with oxygen, the outer with coal-gas or other combustible. The applications of pure oxygen, if it could be prepared cheaply, would be very numerous, and few discoveries would more amply reward the inventor. Among other uses it might be applied to the production of ozone free from nitric acid by the action of the electrical discharge, and to the introduction of that singular body in an efficient form into the arts as a bleaching and oxidising agent. Tessié de Mothay has also proposed to prepare hydrogen gas on the large scale by heating hydrate of lime with anthracite.

We learn from the history of metallurgy that the valuable alloy which copper forms with zinc was known and applied long before zinc itself was discovered. Nearly the same remark may be made at present with regard to manganese and its alloys. The metal is difficult to obtain, and has not in the pure state been applied to any useful purpose; but its alloys with copper and other metals have been prepared and some of them are likely to be of great value. The alloy with zinc and copper is used as a substitute for German silver, and possesses some advantages over it. Not less important is the alloy of iron and manganese prepared according to the process of Henderson by reducing in a Siemens's furnace a mixture of carbonate of manganese and oxide of iron. It contains from 20 to 30 per cent of manganese, and will doubtless replace to a large extent the spiegeleisen now used in the manufacture of Bessemer steel.

The classical researches of Roscoe have made us acquainted for the first time with metallic vanadium. Berzelius obtained brilliant scales which he supposed to be the metal by heating an oxychloride in ammonia, but they have proved to be a nitride. Roscoe prepared the metal by reducing its chloride in a current of hydrogen, as a light grey powder, with a metallic lustre under the microscope. It has a remarkable affinity both for nitrogen and silicon. Like phosphorus it is a pentad, and the vanadates correspond in composition to the phosphates, but differ in the order of stability at ordinary temperatures, the soluble tribasic salts being less stable than the tetrabasic compounds.

Sainte-Claire Deville, in continuation of his researches on dissociation, has examined the conditions under which the vapour of water is decomposed by metallic iron. The iron, maintained at a constant temperature, but varying in different experiments from 150° C. to 1600° C., was exposed to the action of the vapour of water of known tension. It was found that for a given temperature the iron continued to oxidise till the tension of the hydrogen formed reached an invariable value.

In these experiments as Deville remarks, the iron behaves as if it emitted a vapour (hydrogen) obeying the laws of hygrometry. An interesting set of experiments has been made by Lowthian Bell on the power possessed by spongy metallic iron of splitting up carbonic oxide into carbon and carbonic acid, the former being deposited in the iron. A minute quantity of oxide of iron is always found in this reaction.

The fine researches of Graham on the colloidal state have received an interesting extension by Reynolds's discovery of a new group of colloid bodies. A solution of mercuric chloride is added to a mixture of acetone and a dilute solution of potassium hydrate till the precipitate which at first appears is re-dissolved, and the clear liquid poured upon a dialyser which floated upon water. The composition of the colloid body thus obtained in the anhydrous state was found to be $[(CH_3)_2CO]_2Hg_3O_3$. The hydrate is regarded by Reynolds as a feeble acid, even more readily decomposed than alkaline silicates. A solution containing only five per cent forms a firm jelly when heated to 50° C. Analogous compounds were formed with the higher members of the fatty ketone series. In the same direction are the researches of Marcet on Blood, which he finds to be a strictly colloid fluid containing a small proportion of diffusible salts.

In organic chemistry the labours of chemists have been of late largely directed to a group of hydrocarbons which were first discovered among the products of the destructive distillation of coal or oil. The central body round which these researches have chiefly turned is benzol, whose discovery will always be associated with the name of Faraday; with this body naphthaline and anthracene form a series, whose members differ by C_4H_2, and their boiling-points by about 140°. The recent researches of Liebermann have proved, as was before suspected, that chrysene is a fourth member of the same series. I may add that ethylene which boils at about −70° corresponds in composition and boiling-point to a lower member of the same series. Kekule propounded some time ago with great clearness the question as to whether the six atoms of hydrogen in benzol are equivalent, or, on the contrary, play dissimilar parts. According to the first hypothesis, there can be only one modification of the mono- and penta- derivatives of benzol; while three modifications of the bi- tri- and tetra- derivatives are possible. On the second hypothesis, two modifications of the mono-derivatives are possible and in general a much larger number of isomeric compounds than on the first hypothesis. Such is the problem which has of late occupied the attention of some of the ablest chemists of Germany, and has led to a large number of new and important investigations. The aromatic hydrocarbons, toluol, xylol, &c., which differ from one another by CH_2 have been shown by Fittig to be methyl derivatives of benzol. According to the first of the two hypotheses to which I have referred only one benzol and one methyl benzol (toluol) are possible, and accordingly no isomeric modifications of these bodies have been discovered. But the three following members of the series ought each to be capable of existing in three distinct isomeric forms. The researches of Fittig had already established the existence of two isomeric compounds having the formula C_8H_{10},—methyl-toluol obtained synthetically from toluol, and isoxylol prepared by the removal of an atom of methyl from the mesytelene of Kane. The same chemist has since obtained the third modification—orthoxylol—by the decomposition of the paraxylylic acid. These three isomeric hydrocarbons may be readily distinguished from one another by the marked difference in the properties of their tri-nitro compounds, and also by their different behaviour with oxidising agents. Other facts have been adduced in support of the equality or homogeneity of position of the hydrogen atoms in benzol. Thus Hübner and Alsberg have prepared aniline, a mono-derivative from different bi-derivatives, and have alway obtained the same body. The latest researches on this subject are those of Richter.

Baeyer has prepared artificially picoline, a base isomeric with aniline, and discovered by Anderson in his very able researches on the pyridine series. Of the two methods described by Baeyer, one is founded on an experiment of Simpson in which a new base was obtained by heating tribromallyl with an alcoholic solution of ammonia. By pushing further the action of the heat, Baeyer succeeded in expelling the whole of the bromine from Simpson's base in the form of hydrobromic acid and in obtaining picoline. The same chemist has also prepared artificially collidine, another base of the pyridine series. To this list of remarkable synthetical discoveries, another of the highest interest has lately been added by Schiff—the preparation of artificial coniine. He obtained it by the action of ammonia on butyric aldehyde (C_4H_8O). The artificial base

has the same composition as coniine prepared from hemlock. It is a liquid of an amber-yellow colour, having the characteristic odour and nearly all the usual reactions of ordinary coniine. Its physiological properties, so far as they have been examined, agree with those of coniine from hemlock, but the artificial base has not yet been obtained in large quantity nor perfectly pure.

Valuable papers on alizarine have been published by Perkin and Schunck. The latter has described a new acid—the anthraflavic—which is formed in the artificial preparation of alizarine. Madder contains another colouring principle, purpurine, which like alizarine yields anthracene when acted on by reducing agents, and has also been prepared artificially. These colouring principles may be distinguished from one another, as Stokes has shown by their absorption-bands, and Perkin has lately confirmed by this optical test the interesting observation of Schunck that finished madder prints contain nothing but pure alizarine in combination with the mordant employed.

Hofmann has achieved another triumph in a department of chemistry which he has made peculiarly his own. In 1857 he showed that alcohol bases, analogous to those derived from ammonia, could be obtained by replacement from phosphuretted hydrogen; but he failed in his attempts to prepare the two lower derivatives. These missing links he has now supplied, and has thus established a complete parallelism between the derivatives of ammonia and of phosphuretted hydrogen. The same able chemist has lately described the aromatic cyanates, of which one only—the phenylic cyanate (CO,C_6H_5,N)—was previously known, having been discovered about twenty years ago by Hofmann himself. He now prepares this compound by the action of phosphoric anhydride on phenylurethane, and by a similar method he has obtained the tolylic, xylylic, and naphthylic cyanates.

Stenhouse had observed many years ago, that when aniline is added to furfurol, the mixture becomes rose-red, and communicates a fugitive red stain to the skin, and also to linen and silk. He has lately resumed the investigation of this subject, and has obtained two new bases, furfuraniline and furfurtoluidine, which like rosaniline form beautifully coloured salts, although the bases themselves are nearly colourless or of a pale brown colour. The furfuraniline hydrochlorate ($C_{17}H_{19}O_2N_2Cl$) is prepared by adding furfurol to an alcoholic solution of aniline hydrochlorate, containing an excess of aniline. We have also from Stenhouse a new contribution to the history of orcin, in continuation of his former masterly researches on that body. He has prepared the trinitro-orcin—

$$(C_7H_5(NO_2)_3O_2),$$

a powerful acid, having many points of resemblance to picric acid. In connection with another research of Stenhouse made many years ago, it is interesting to find his formula for euxanthon, which was also that of Erdmann, confirmed by the recent experiments of Baeyer.

The interesting work of Dewar on the oxidation of picoline must not be passed over without notice. By the action of the permanganate of potassium on that body, he has obtained a new acid, which bears the same relation to pyridine that phthalic acid does to benzol. Thorpe and Young have published a preliminary notice of some results of great promise, which they have obtained by exposing paraffin to a high temperature in closed vessels. By this treatment it is almost completely resolved into liquid hydrocarbons, whose boiling-points range from 18° C. to 300° C.: those boiling under 100° have been examined and consist chiefly of olefines. In connection with this subject it may be interesting to recall the experiments of Pelouze and Cahours on the Pennsylvanian oils, which proved to be a mixture of carbohydrogens belonging to the marsh gas series.

An elaborate exposition of Berthelot's method of transforming an organic compound into a hydrocarbon containing a maximum of hydrogen has appeared in a connected form. The organic body is heated in a sealed tube with a large excess of a strong solution of hydriodic acid to the temperature of 275°. The pressure in these experiments Berthelot estimates at 100 atmospheres, but apparently without having made any direct measurements. He has thus prepared ethyl hydride (C_2H_6) from alcohol, aldehyde, &c.; hexyl hydride (C_6H_{14}) from benzol. Berthelot has submitted both wood charcoal and coal to the reducing action of hydriodic acid, and among other interesting results he claims to have obtained in this way oil of petroleum.

By the action of chloride of zinc upon codeia, Matthiessen and Burnside have obtained apocodeia, which stands to codeia in the same relation as apomorphia to morphia, an atom of water being abstracted in its formation. Apocodeia is more stable than apomorphia, but the action of reagents upon the two bases is very similar. As regards their physiological action, the hydrochlorate of apocodeia is a mild emetic, while that of apomorphia is an emetic of great activity. Other bases have been obtained by Wright by the action of hydrobromic acid on codeia. In two of these bases, bromotetracodeia and chlorotetracodeia, four molecules of codeia are welded together so that they contain no less than 72 atoms of carbon. They have a bitter taste, but little physiological action. The authors of these valuable researches were indebted to Messrs. Macfarlane for the precious material upon which they operated.

We are indebted to Crum Brown and Fraser for an important work on a subject of great practical as well as theoretical interest, the relation between chemical constitution and physiological action. It has long been known that the ferrocyanide of potassium does not act as a poison on the animal system; and Bunsen has shown that the kakodylic acid, an arsenical compound, is also inert. Crum Brown and Fraser find that the methyl compounds of strychnia, brucia, and thebaia, are much less active poisons than the alcaloids themselves, and the character of their physiological action is also different. The hypnotic action of the sulphate of methyl-morphium is less than that of morphia. But a reverse result occurs in the case of atropia, whose methyl and ethyl derivatives are much more poisonous than the salts of atropia itself.

Before proceeding to the subject of fermentation, I may refer to Apjohn's chemico-optical method of separating cane sugar, inverted sugar, and grape sugar from one another when present in the same solution, by observing the rotative power of the syrup before and after inversion, and combining the indications of the saccharometer with the results of an analysis of the same syrup after inversion. Heisch's test for sewage in ordinary water is also deserving of notice. It consists in adding a few grains of pure sugar to the water and exposing it freely to light for some hours, when the liquid will become turbid from the formation of a well-marked fungus, if sewage to the smallest amount be present. Frankland has made the important observation that the development of this fungus depends upon the presence of a phosphate, and that if this condition be secured the fungus will appear even in the purest water.

The nature of fermentation, and, in particular, of the alcoholic fermentation, has been lately discussed by Liebig with consummate ability, and his elaborate memoir will well repay a careful perusal. Dr. Williamson has also given a most instructive account of the subject, particularly with reference to the researches of Pasteur, in his recent Cantor lectures. A brief statement of the present position of the question will, therefore, not be out of place here. It is now 34 years since Cagniard de La Tour and Schwann proved, by independent observations, that yeast globules are organised bodies, capable of reproduction by germination; and also inferred, as highly probable, that the phenomena of fermentation are induced by the development or living action of these globules. These views, after having fallen into abeyance, were revived and extended, a few years ago, by Pasteur, whose

able researches are familiar to every chemist. Pasteur, while acknowledging that he was ignorant of the nature of the chemical act, or of the intimate cause of the splitting up of sugar in the alcoholic fermentation, maintained that all fermentations, properly so called, are correlative with physiological phenomena. According to Liebig, the development and multiplication of the yeast plant or fungus is dependent upon the presence and absorption of nutriment which becomes part of the living organism, while, in the process of fermentation, an external action takes place upon the substance, and causes it to split up into products which cannot be made use of by the plant. The vital process and the chemical action, he asserts, are two phenomena which, in the explanation, must be kept separate from one another. The action of a ferment upon a fermentable body he compares to the action of heat upon organic molecules, both of which cause a movement in the internal arrangement of the atoms. The phenomena of fermentation Liebig refers now, as formerly, to a chemico-physical cause, the action, namely, which a substance in a state of molecular movement exercises upon another, of highly complex constitution, whose elements are held together by a feeble affinity, and are to some extent in a state of tension or strain. Baeyer, who considers that in the alcoholic and lactic fermentations one part of the compound is reduced and another oxidised, adopts the view of Liebig, that the molecules of sugar which undergo fermentation do not serve for the nourishment of the yeast plant, but receive an impulse from it. All are, however, agreed that fermentation is arrested by the death of the plant; and even a tendency to the acetous fermentation in wine may be checked, as Pasteur has shown, by heating the wine to a temperature a little below the boiling-point in the vessel in which it is afterwards to be kept.

I regret that the limits of an address like the present forbid me to pursue further this analysis of chemical work. Had they admitted of abridgment, I should gladly have described the elaborate experiments of Gore on hydrofluoric acid and the fluoride of silver. The important researches of Abel on explosive compounds will be fully explained by himself in a lecture with which he has kindly undertaken to favour the Association. Mr. Tomlinson will also communicate to the section some observations on catharism and nuclei, a difficult subject to which he has of late devoted much attention. And I am also informed that we shall have important papers on recent improvements in chemical manufacture.

No one can be more painfully alive than myself to the serious omissions in the historical review I have now read, more particularly in organic chemistry, where it was wholly impossible to grapple with the large number of valuable works which even a few months produce. I cannot, however, refrain from bearing an humble tribute to the great ability and indomitable perseverance which characterise the labourers in the great field of organic chemistry. It would scarcely be possible to conceive any work more intelligently undertaken or more conscientiously performed than theirs, yet much of it, from its abstruse character, receiving little sympathy or encouragement, except from the band of devoted men who have made this subject the chief pursuit of their lives. They will, however, find their reward in the consciousness that they have not lived in vain, but have been engaged, and successfully engaged, in the noble enterprise of extending, for the benefit of the human family, the boundaries of scientific knowledge. Nor is there any real ground for discouragement. Faraday, Graham, Magnus, and Herschel, who have left their impress on this age, were all distinguished chemical as well as physical discoverers; and the relations of the sciences are becoming every day so intimate that the most special research leads often to results of wide and general interest. No one felt this truth more clearly, or illustrated it better in his writings, than our lamented and distinguished friend, Dr. Miller, whose presence used to cheer our meetings, and whose loss we all most sincerely deplore.

EXPERIMENTS ON FORMATION OF RING VORTICES (WITH SECONDARY PHENOMENA) IN WATER.*

By HENRY DEACON, J.P., F.C.S.

In the course of an experimental research on the motion of fluids, I was very recently working with water very slightly coloured with indigo dissolved in sulphuric acid, projected into spring water, the object being to have both fluids of precisely the same specific gravity. My assistant had prepared the two fluids with a specific gravity bottle in the ordinary laboratory balance, and we were together in a quiet room, with the water quite at rest to commence the research. A phenomenon occurred which I at once said arose from the coloured fluid being the heavier. My assistant referred to his weighings in the laboratory. It occurred to me that if a drop of the coloured water were very gently placed in the perfectly still clear water, the motion of the coloured drop would decide the point; if heavier it would sink. It did sink, but in sinking gave rise to the phenomena now referred to, some of which I hope to succeed in showing you.

To describe what to look for, I refer to the accompanying supplementary plate. Fig. 1 is a ring—a "smoke ring" in miniature. Fig. 2 indicates the commencement of the next change, the formation of nodes, varying much in number and position, influenced by currents in the water, shape of the drop, &c. Fig. 3 shows how, by descending, the nodes begin to develope secondary rings, shown in an advanced state of development in Fig. 4, the centre of each secondary ring being connected with the centre of the one on each side of it by a delicate arch. If coloured solutions are used, and the vessel not too deep and with a flat bottom, this crown-like structure will for a few minutes rest on the bottom, with the arches springing up from circle to circle. Fig. 5 is a rough indication of what frequently happens when the secondary rings and connecting links descend well below the primary rings, and tolerably uniformly. A rather rapid contraction and drawing-up of the tops of the arches takes place; that is, while the lower series of secondary rings continue to descend, the upper part of the structure rapidly descends and contracts. This upward motion lasts but a short time, and then the whole fabric descends altogether. Occasionally, and under circumstances I cannot speak of with certainty, a form is seen of which Fig. 6 is a very feeble illustration. The arches from the secondary rings are here connected by a delicate film; this is contracted into a tube, the upper part of which turns over like a deeply-recurved convolvulus. Working with a very attenuated solution of permanganate of potash, the secondary rings resting on the bottom of the beaker, or wholly suspended in the water, it strikingly resembles a living animal, like a sea anemone. As all this structure is formed from one single drop its extreme tenuity can be easily imagined. The resemblance of these structures to organisms is more than in form. Whilst they are growing they are, so to say, "alive," bright colours and clearly-defined objects. When they cease to grow their "life" ceases too, they become dull, flaccid, nebulous,—they quickly dissolve into the surrounding space,—they *die*. In Fig. 7 I have attempted to show the motion of the "rings" themselves, and the cause to which I ascribe the phenomena indicated in Figs. 5 and 6. The motion of the "ring" is the same as that of the "smoke-rings," reversed, of course, because these "rings" descend instead of ascend. In water, this motion ceases almost entirely, and the whole "ring" descends bodily. In this descent water is displaced, and a current due to this displacement flows upwards through the "ring" centre, as shown by the long arrows. There is, of course, an ascending current outside the ring, but this is spread

* Read before the British Association, Edinburgh Meeting, Section B.

FIG. 1.

FIG. 2.

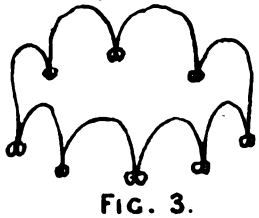

FIG. 3.

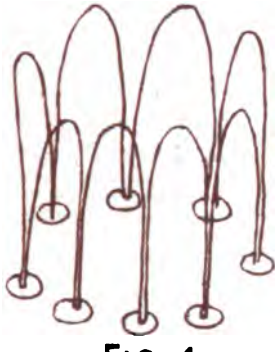

FIG. 4.

FIG. 5.

FIG 6.

FIG 8.

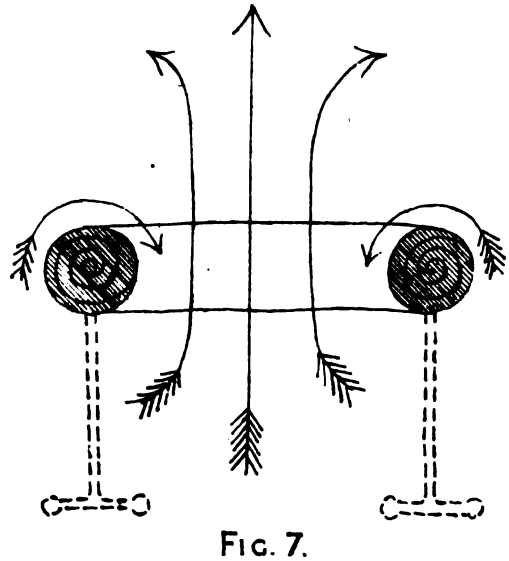

FIG. 7.

RING VORTICES IN WATER

HENRY DEACON.

WIDNES, 25TH JULY,

1871.

over a larger area, whilst that inside the ring is more concentrated and of greater velocity; it therefore overcomes the outside induced current so far as these phenomena are concerned. Where the secondary "rings" and their connecting arches descend, they obstruct the access of the water to the internal ascending column. A result ensues similar to that of the water-ram. The column continues its motion, its viscosity causes it to elongate, and diminishes in diameter, thus elongating and contracting the adjacent parts of the "ring." The top is re-curved by this column of water beating against the still water above it, in just the same way that the "ring" itself is formed by the drop in motion beating against the water at rest. Fig. 8 feebly represents one of the ordinary phenomena when a faint stream descends, the end is re-curved, and a ring surrounds the re-curved part, just like a delicate fungus upside down. Water holding solid matters in suspension serve well to illustrate these rings and secondary rings, but is, I think, unsuitable for the succeeding forms. I prefer coloured solutions for the remainder of the phenomena. A very brief interval has elapsed since I first saw these rings, and very numerous avocations preclude the idea of my doing much more with them. One thought in connection with them has occurred to me: secondary rings give rise to tertiary rings, and these to a fourth series, and perhaps more.

May not this tendency to form, from merely straight currents, structures at intervals in planes at right angles to the current, throw light on the formation of clouds in strata? A vertical ascending current of vapour develops a structure in a horizontal plane, that is the first stratum of clouds. From this structure vertical columns again arise, and secondary, and, in turn, other structures are formed at various heights, but each in distinct planes. To obtain these rings to perfection, the water must be perfectly still, the drop as nearly the same specific gravity as possible, but the heavier of the two. The dropping-tube, or rod, must deliver a nicely-shaped drop, and this must enter the water quietly and with very little impetus. Some impetus it must have, but too much breaks up the drop, sometimes giving rise to a mere cloud, and sometimes to two or more very small rings, and more or less figures like Fig. 8. With solutions of rather higher specific gravity from dissolved substances the motion of the rings is more violent, but I do not think the phenomena so characteristic. Diffusion comes into play and breaks up the structure.

The secondary phenomena appear to be influenced by the chemical nature of the colouring matter, as illustrated by the different action of the permanganate and indigo solutions, and the secondary rings are always the edge of a thin film of the original drop, never, so far as I have observed, being distinct ring vortices. I should like to see these figures formed from some suitable solution, and illuminated by polarised light or the invisible rays of the spectrum. Somewhat striking experiments could, I think, be devised by having the receiving vessel filled in layers with solutions differing very little from each other in specific gravity, but containing different salts, so that a drop of another kind of solution should, in passing through the different layers, become alternately visible and invisible, or of different colours.

I think these "rings" will serve to illustrate the laws of vortices of motion, as Attwood's machine serves to illustrate some of the laws of bodies in motion. The proportions are preserved in a diminished scale and brought within easy observation. My conviction, based on some very hasty observations, is that phenomena similar to sensitive flames and their congeners can be obtained and studied by the aid of streams of coloured solutions in colourless fluids. That the "rings" are very sensitive to vibrations like those of sound is evidenced by the influence exerted by the diameter and depth of water into which the drop falls. The larger the diameter and the greater the depth, the more complete the series of characteristic transformations. Amongst the possibilities I hope some day to effect with these rings, is their exhibition as solids. Imagine a drop of melted wax, paraffin, sulphur, &c., falling into a suitable solution, and descending into a cold stratum; should we not have a frozen ring?

ON THE ESTIMATION OF SULPHUR BY BARIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

A SOLUBLE salt of barytes, *terra ponderosa*, appears to have been used from the beginning of the art of chemical analysis as the most trustworthy agent for ascertaining the existence, and determining the amount of sulphuric acid present in solutions. The delicacy of the test, and the insolubility of the resulting sulphate, seemed to leave nothing to be desired in the reliance to be placed on the results yielded by barytes when used in analysis for estimating sulphuric acid.

As the methods of oxidation of the sulphides, and the conversion of their sulphur into sulphuric acid, were discovered, the extension of the use of barytes to the estimation of sulphur soon took place; and, until a comparatively recent period, no doubt was entertained that the weight of the sulphate of barytes yielded by any given salt or solution would indicate, unerringly and with exactness, the amount of sulphur present in a sulphide, whether factitious or native. The reliance placed upon the accuracy of a determination of sulphuric acid or sulphur by means of sulphate of barytes precipitated from a dilute acid and boiling solution, allowed to cool, and the precipitate copiously washed with hot water, in the first instance acidified with hydrochloric acid, when dried and ignited—was, within the memory of many, absolute; and the manuals of analysis of the period we refer to do not even hint at the possibility of error. Yet it is well-nigh certain that in every instance of such a determination of sulphur or sulphuric acid, the results are not trustworthy and only approximate to accuracy, and this chiefly because the combining equivalent of barium was then reckoned at some two per cent higher than now, 70 instead of 68·50, so that error in the weight of the barytic sulphate was, in great measure, compensated by the error in the equivalent.

With the advance in the art of chemical analysis, it was found that precipitated sulphate of barytes had a marked tendency to carry down with it variable quantities of other salts contained in the solution, such as those of soda, potash, barytes, magnesia, iron, copper, &c.; and the later treatises on analysis give detailed directions to purify the precipitated sulphate from the adherent salts, directions which, even if efficient, are tedious and troublesome, and, at the best, leave the results still subject to doubts of its accuracy. Hence there has been a tendency manifesting itself to prefer volumetric to gravimetric methods for estimating sulphur; and these have undoubtedly been attended with greater accuracy than formerly, despite the objections inherent in all volumetric methods.

Of late years, since the general adoption of pyrites for alkali-making in lieu of brimstone, accuracy in the estimation of sulphur has become a matter of some commercial importance; and, as in our practice we know but too well how variable are the results certified to as having been obtained by professed analysts from carefully-prepared and similar samples of pyrites, which we have good grounds for regarding as identical samples, we hope that some remarks on the difficulties attending an accurate estimation of sulphur by barium, and the details of a rapid and reliable method when applied to pyrites, long practised by us, may prove acceptable to many interested in the subject, and, we would fain hope, put an end to the gross errors now so frequently brought to our notice in the estimation of sulphur in pyrites, a subject which has been

lately dwelt-upon by the President of the Chemical Society of Newcastle-on-Tyne, and reported in the last volume of the CHEMICAL NEWS, p. 57, and his remarks are so much to the point that we quote them *in extenso* :—

"I beg to draw your attention to this tabulated result of seven different samples of sulphur ore (pyrites), by three different chemists, each having the same sample to operate on.

No.	Sulphur per cent. A.	B.	C.	Difference between A and B.	Difference between A and C.
1.	38·80	38·00	40·20	0·80	1·40
2.	40·90	40·90	42·70	—	1·80
3.	39·60	39·10	41·10	0·50	1·50
4.	39·30	39·50	40·70	0·20	1·40
5.	41·60	41·40	43·50	0·20	1·90
6.	38·20	38·00	40·00	0·20	1·80
7.	39·70	39·20	41·10	0·50	1·40
			Average	0·34	1·60

"You will observe that between A and B, there is comparatively little difference, the maximum amount being 0·80, while between A and C the maximum difference is 1·90; the average difference between A and B is only 0·34, but the average difference between A and C is 1·60.

"I ought to mention that A and B are local chemists, but residing and working in different parts of the district, and acting quite independently of each other, and that C is a metropolitan chemist; also that A and C are professional chemists, B is chemist in the laboratory of the purchasers of the ores."

Probably it would be found on inquiry that different methods of estimating the sulphur in the foregoing experiments have been adopted by the local and the metropolitan chemists above-mentioned; as, whilst the average difference between the professional chemists amounts to 1·60 per cent of sulphur, this rises to almost 2 per cent, if the results of the purchasers' chemist are compared with those of the metropolitan analyst.

In estimating the sulphur in pyrites by the weight of the sulphate of barytes obtained, it must have struck every analyst that the resulting sulphate, after ignition, is usually stained with iron oxide; and also it *may* have been noticed by him, when he has endeavoured to prevent a deep stain by washing the precipitated sulphate with but moderately diluted hot hydrochloric acid previously to collecting the precipitated on a filter, and has kept the filtrate and washings for a day or two, that the sides and bottom of the beaker have been covered with a film, gradually deposited by the previously clear and bright filtrate; but we are unaware that this fact has been commented on, or met with the notice it deserves, proving, as it does, that *sulphate of barytes is noticeably soluble in hot and but moderately diluted hydrochloric acid.* Here, we doubt not, is one source of the differences spoken of in the estimation of sulphur in pyrites by different chemists; nor is this source of error a slight one, especially when we remember that it is the practice of many to operate on but small amounts of pyrites, so that any analytic error is considerably multiplied and augmented when the results are reported *per centum.* True it is that the solubility of the sulphate in hydrochloric acid has already been pointed out, but the importance of this fact has been underrated, and esteemed as but little likely to affect the estimation of sulphur by barium. On the other hand, the adhesion of chloride of barium to the precipitated sulphate is also known, but this does not appear to have excited the same attention of writers on the subject as the analogous case of the nitrate of barytes, which most markedly affects the weight of the barytic sulphate. Thus, 108·60 grs. of crystallised sulphate of iron, equal to 91 grs. of sulphates of barytes, when oxidised in the usual way, but the excess of nitric acid not expelled, yielded 94·20 grs. of sulphate of barytes, being an excess of 3·20 grs. beyond the calculated weight. These sources of error may, however, be somewhat compensated by a partial reduction of the sulphate during ignition, for it must be remembered that the barytic is one of the most readily decomposed of the earthy sulphates, by ignition in contact with deoxidising agents, so that evidence of the presence of barytes on treating the ignited sulphate by water or dilute acid must not be regarded as proving that nitrate or chloride has adhered to the precipitate. Thus, some precipitated and ignited sulphate of barytes, when treated first with water and then with diluted hydrochloric acid, washed and re-ignited, and again treated with water and dilute acid, six consecutive times, yielded each time traces of chlorine and barytes to water only, and a considerable amount of barytes to the dilute acid, proving that sulphate of barytes is sensibly reduced when ignited to redness in the usual manner. From the foregoing, it will be seen that pitfalls abound in the estimation of sulphur by barium.

We had long since found that one requisite, and that an essential one, in the correct estimation of sulphur, was to obtain a soluble sulphate of stable composition, the basic element of which should not be adherent to the barytic sulphate; and this was found in crystallised sulphate of iron. Sulphate of potash seemingly offered a better fixed standard, as this salt is anhydrous, and is readily procured in a state of absolute purity, but long experience had shown us that no salt yielded more discordant results with barytes than sulphate of potash. The sulphate of iron we speak of has, of late years, become an article of commerce, and occurs in hard, separate, and small crystals, very uniform in size. This is crushed to the size of hemp-seed, and the dust and smaller fragments sifted out; then washed by shaking with repeated portions of methylated spirit, and rapidly dried on bibulous paper, when a brilliant hard salt of a light beryl-colour, free from interposed water or per-salt is obtained, which is perfectly stable and unvarying in composition. There is a further advantage attached to the use of crystallised sulphate of iron, viz., that a considerable weight of this salt indicates but a small amount of sulphur, 108·60 grs. being equal to 12·50 grs. of sulphur, the amount of sulphur, or thereabouts, we find to be the best and most reliable for working on in ordinary practice with pyrites; and, moreover, when the solution of this salt is oxidised, the result is identical with that produced by the oxidation of pyrites.

A series of experiments was made by dissolving 108·60 grs. of the above described crystallised sulphate of iron in 2000 grs. of water, acidifying the solution with 500 measured grs. of hydrochloric acid, sp. gr. 1·160; and, precipitating this solution by an equally dilute and acidified solution of chloride of barium, the latter always in moderate excess, and both solutions boiling at the time of precipitation, the subjoined weights of sulphate of barytes were obtained :—

No. 1.	91·90	grs. of	sulphate of	barytes.
„ 2.	92·90	„	„	„
„ 3.	92·10	„	„	„
„ 4.	91·25	„	„	„
„ 5.	90·80	„	„	„
„ 6.	91·90	„	„	„
„ 7.	91·30	„	„	„
„ 8.	91·50	„	„	„
„ 9.	91·60	„	„	„

The calculated weight, or that which ought to have been obtained, in each instance being 91·02, practically 91 grs. of sulphate of barytes.

(To be continued).

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THE CHEMICAL NEWS.

VOL. XXIV. No. 611.

EXPERIMENTS ON CHEMICAL DYNAMICS.*

By J. H. GLADSTONE, F.R.S., and ALFRED TRIBE, F.C.S.

THE authors had recently communicated a paper to the Royal Society in which they investigated somewhat minutely what takes place when a plate of one metal, such as copper, is immersed in a solution of a salt of another metal, such as nitrate of silver. They had shown that, while the silver was being deposited on the copper, an actual passage of the nitric element towards the more positive metal occurs, causing the formation of a dense solution of nitrate of copper inside the crystalline deposit, and a consequent downward current, and at the same time an upward current of almost pure water from the tips of the crystals. They had shown, also, that with solutions of different strengths the chemical action in a given period (say ten minutes) is not in direct proportion to the strength; but, *cæteris paribus*, twice the strength gives three times the chemical decomposition. This augmentation had been attributed to an increased conduction of the stronger liquid. In the present paper, the authors exhibited these phenomena in a dissected form, and carried the observations still further.

Instead of the silver crystals being allowed to grow rom the copper into the nitrate of silver solution, two separate plates were taken, one of copper and the other of silver. The copper plate was immersed in nitrate of copper, and the silver plate in nitrate of silver, while the two metals were connected by a wire, and the two liquids were connected by a porous cell. Silver crystals were gradually formed upon the silver plate, while the copper was dissolved; and at the end of some hours it was found that all the silver had been removed from solution, and that the loss of the copper plate was almost exactly what might be calculated from the amount of nitrate of silver originally placed in the other cell. The actual numbers were—theoretical, 0·412; actual, 0·402. The copper nitrate was formed in the cell with the copper plate, the sp. gr. of the liquid having risen from 1·015 to 1·047.

A similar experiment was tried with plates of copper and zinc in sulphate of copper and sulphate of zinc, respectively. The result was as before, metallic copper being deposited on the copper plate, and the sulphate of zinc rising in sp. gr. from 1·123 to 1·139.

In order to determine whether the amount of silver deposited depended, not merely on the amount of the silver in solution, but also on the amount of copper salt that bridged over the intervening space, similar experiments were made in which the nitrate of silver was kept constant, but the nitrate of copper was increased by equivalent multiples. It was found that the silver deposited increased with the increase of the copper salt, being about double when the copper salt was seven times as strong, and that the effect of successive additions gradually diminished. This is in strict accordance with other experiments, showing that, when the copper plate is immersed in a mixture of the nitrates of copper and silver, the amount of silver deposited is increased, and increases with each successive addition of copper salt, though in a diminishing ratio.

That this acceleration is not produced by a copper salt only was proved by repeating the experiment with a variety of other nitrates.

The subjoined table shows the results, and indicates, at the same time, that the increased effect does not depend simply upon the nitric element, which was present in the same quantity in all, but likewise on the nature of the salt.

Size of plate, 3230 sq. m.m.; volume of solution, 72 c.c., containing 2·8 per cent of nitrate of silver; temperature, 18° C.; time, five minutes.

Solution.	Copper dissolved. Grms.	Increase per cent.
Nitrate of silver	0·0703	—
Ditto + 1 eq. of nitrate of magnesium	0·1010	43·6
" " " calcium ..	0·1003	42·6
" " " sodium ..	0·0957	36·1
" " " copper ..	0·0965	37·2
" " " potassium	0·1047	48·9
" " " strontium	0·1040	47·9
" " " cadmium ..	0·1030	46·5
" " " barium ..	0·0987	40·3
" " " lead	0·0945	34·4

* Read before the British Association, Edinburgh Meeting, Section B.

ON A NEW SOURCE OF ELECTRICITY.

By JAMES St. CLAIR GRAY, M.B., C.M., &c.,
Assistant to the Professor of Medical Jurisprudence, Glasgow University.

IN the course of some experiments relative to sulphur and phosphorus, my attention was drawn to their mutual action while in alkaline solutions, and it occurred to me that probably from this there might be derived an electric currrent.

In order to ascertain this, as well as to determine—should there prove to be such—whether it was constant or not, there was prepared a cell containing a solution of caustic potash in which phosphorus and sulphur, both in sticks, were placed. Within half an hour the phosphorus was reduced to an oily mass, perfectly mobile, occupying the lower part of the cell; the sulphur was not at first affected. The temperature at first rose considerably—about 20°—but this soon passed off, and the solution returned to the temperature of the surrounding medium, varying from 56° to 60° F. During the first six days there was a constant development in small quantity of phosphuretted hydrogen in the spontaneously inflammable form, but after that time, although phosphuretted hydrogen still continued to be evolved, it no longer ignited spontaneously, this being probably due to the simultaneous development of sulphuretted hydrogen, which began to be exhaled in appreciable quantity about this time. At first the sulphur was little affected, but at the end of ten days it was found that at the point of junction of the phosphorus therewith there had occurred considerable loss of substance.

In the solution there were produced sulphite and phosphite, hyposulphite and hypophosphite, and slight traces of sulphate and phosphate of potassium.

At the end of three months the conditions were still much the same; the phosphorus was still fluid and mobile, the sulphur more eroded, the same products present in solution, though increased in quantity and somewhat altered in the ratio which the one salt bore to the other: due allowance being made for increase, the proportion of sulphate and phosphate was greater.

Another cell was prepared on the same principle, and both cells were then submitted to Mr. Hill, one of the assistants in Sir William Thomson's laboratory, to determine the amount of electricity developed, if any. The result far exceeded my expectations, for not only was electricity found to be developed, but a very considerable quantity thereof. The electro-motive force, as registered by Sir William Thomson's electrometer, was found to be 162, which, compared with that of a Daniell's battery, 120, shows a difference in favour of the sulphur and phosphorus of 42°. It was, further, also found that in the cell which had been in opera-

tion for three months, the reading of the scale was quite the same, so that from this cell there was derived an electric current of considerable intensity which had the advantage of being constant.

Wishing then to obtain again in its solid state the residuum of phosphorus which lay at the bottom of the cell, I removed the rolls of sulphur and the alkaline solution, replacing it by pure water, and washing till free of alkali. The phosphorus, under water, was kept for ten days perfectly undisturbed, but at the end of that time was as mobile as ever. A stick of solid phosphorus was then placed among the fluid mass without inducing solidification; on the other hand, the solid become liquefied in a short time. It was then cooled down to 34° F., but still remained fluid, so that I have it still by me in the same mobile, oily condition without apparently any change occurring, though, since the removal of the alkali, nearly two months have elapsed. To what this is due I cannot say, though, I believe, it depends on the presence of some compound of sulphur and phosphorus, as both are present; though in what proportion I cannot at present state.

I am at present engaged in further observations on this and other allied subjects, the results of which I shall hereafter make known.

15, Newton Terrace, Glasgow,
July 22, 1871.

ON THE BEHAVIOUR OF SUPERSATURATED SALINE SOLUTIONS WHEN EXPOSED TO THE OPEN AIR.*

By CHARLES TOMLINSON, F.R.S.

It is known that, when a vessel containing a supersaturated saline solution is opened in a room, it immediately crystallises, provided the temperature be not too high. Mr. Tomlinson shows that supersaturated solutions of Glauber's salt (and also of Epsom salt, and of alum) may be exposed to the open air of the country for many hours, and even be taken out of the flasks in clean metal spoons, without crystallising. From a large number of experiments, conducted under various conditions, the following conclusions are drawn:—

1. That a highly supersaturated solution of sodic sulphate may be exposed to the open air of the country in an uncovered flask, and in cloudy weather, for from twelve to twenty hours, without any formation of the ordinary ten-watered salt.

2. That if the temperature fall to 40° F., and under, the modified seven-atom salt is formed at the bottom of the solution, just as in covered vessels.

3. That if the exposed solution suddenly crystallises into a compact mass of needles, a nucleus may always be found in the form of an insect, a speck of soot, a black point of carbon, &c.

4. That if, during the exposure, rain come on, the solution generally crystallises suddenly, in consequence of an active nucleus being brought down. But if the flask be put out *during* heavy rain, when we may suppose all the solid nuclei to have been brought down, the rain-drops, now quite clean, fall into the solution without any nuclear action.

5. That the young and newly-sprouted leaves of trees, such as the gooseberry and currant bushes, have no nuclear action.

6. That, in clear cloudless weather, when the force of evaporation is strong, the solutions, by exposure, produce fine groups of crystals of the ten-atom salt, just as a saturated solution would do if left to evaporate slowly in an open dish.

7. That if the solution, after being exposed to the open air, be brought into a room, it crystallises immediately under the action of aërial nuclei.

* Read before the British Association, Edinburgh Meeting, Section B.

ON THE ORIGIN OF THE DIAMOND.*

By the Rev. W. B. CLARKE, M.A., F.G.S.

(Continued from p. 42).

Diamonds in India.

We may now turn to another quarter. India was renowned as a diamond country long before Brazil; Tavernier mentions diamonds in 1642.

In 1814, Dr. Heyne published some tracts on India, in which he described the diamond mines of Southern India, showing that a conglomerate caps the Cuddapah Hills; and he adds, wherever diamonds are found they are in alluvia aud recent deposits in which the rounded pebbles are so numerous as to produce the conglomerate character.

In 1832, Mr. Cullinger published in a Calcutta periodical—"Gleanings in Science"—some notes on the geology of the country between Saugor and Mirzapore, in which he mentions the occurrence of diamonds in solid sandstone underlying chlorite slate, and also in a ferruginous agglomerate, of which he gives several localities.

Mr. Newbold in a paper that may be found in the *Athenæum* of June 11, 1843, has described the diamond-bearing gravel of Cuddapah, in Bundelcund, a little south of Golconda.

It holds rounded pebbles of trap, granite, schists derived from beds twenty to forty miles distant, quartz, jasper, silex, sandstone, and limestone of the vicinity. In it are broken or rolled diamonds; and as the diamond beds are occasionally covered by *Regur*, or black cotton soil (which is also not uncommon in Australia), I consider they are of the same age as the older drift of the Cudgegong. But when these materials are cemented at the upper part by *Kunkur*, which is a tufaceous carbonate of lime (very common in some parts of Australia), diamonds are *never* found. In the Nizam's territory, such cemented beds contain bones of the Mastodon.

If the fifth volume of the second series of *Transactions of the Geological Society of London* is a valuable memoir "On the Fossils of the Eastern portion of the great Basaltic district of India," by the late Mr. Malcolmson, which was read in November and December, 1837. In it he alludes to the Cuddepah diamond mines, in the neighbourhood of which is abundance of basalt. He gives also a sketch of the position of the diamond sandstone of Bangnapilly, which is horizontal, vertically jointed, resting on schistose beds underlain by stratified limestone, and surmounted by a diamond-bearing breccia, which is not interstratified, but is a mixture of sandstone and other rocks, rounded and angular, On the opposite side of the valley, according to Colonel Cullen, the sandstone is replaced by a sharp ridge of trap, and on the descent the schist and limestone were found to be capped by a quartzose sandstone. Besides the diamond conglomerate, seams of rock crystal occur, and fine white quartz charged with galena, and with specular, micaceous, and pyritous iron. The slates are occasionally flinty or jaspideous. The base of the whole is the granite of the Carnatic, and this rock is penetrated by many dykes of greenstone. In the diamond sandstone, magnetic iron and corundum are met with. The fossils in the argillaceous limestone are of fresh water origin.

Mr. Malcolmson opposes the idea of Major Franklin, that the diamond rocks belong to the saliferous deposits of England. In this part of Bundelcund, greenstone follows the strike of the so-called grauwacke in the bed of the Nerbudda River, and basalt forms the overlying strata, another analogy with the Cudgegong diamond district.

Mr. Broderip considered the rocks to be jurassic, and scarcely distinguishable from the white lias of Bath.

As to the saliferous beds, Mr. Malcolmson says, there is not a rock formation in India from granite to recent alluvium in which salt does not exist; and he further states, that the sandstone, covering 800 miles of latitude

* From the Anniversary Address delivered to the Royal Society of New South Wales.

and 400 of longitude, is everywhere above the limestone which Captain Franklin calls *lias*.

In 1853, Mr. Carter, in his "Summary of the Geology of India" (*Bombay Asiat. Soc.*, 1854), also adopts the view that these Bundelcund diamond rocks are jurassic.

D'Archiac (*Progrès*, vol. vii., p. 644) repeats Carter's statements, and puts the diamond-bearing conglomerate *with a note of interrogation* above the Punnah sandstone, and much above the carbonaceous shales of Kuttra.

I would here wish to remark that these beds must be distinguished from those which hold *glossopteris*, and which paralleled with the African Karoo beds, Mr. Tate (*Q. J.*, xxiii.) in 1867, considered triassic, whilst Dr. Oldham, the experienced and able Superintendent of the Geological Survey of India, agrees with me in assigning them to a palæozoic epoch. But inasmuch as coal may exist in the jurassic or triassic, as well as upper palæozoic formations, the proximity of a coal-bearing formation to the diamond rock leaves the question as to the origin of diamond in such a formation just where it was.

Since the establishment of the Indian Survey, under its present enlightened Superintendent, the Messrs. Blandford and Mr. Theobald have explored large tracts of India, and have given their opinion, in which Dr. Oldham concurs, that the Nagpur, Damoodah, and Talcheer, as well as other Bengal coal-fields, cannot be younger than permian. (*Mem. Ind. Surv.*, vol. i., p. 82). These beds in the Damoodah group hold many species identical with those of our New South Wales coal districts, including the outlying patches on the Cudgegong.

The Indian surveyors show that the Mahadeva sandstone (or Bangnapilly rock) surmounts the Damoodah beds, believed to be permian, and that the Talcheer group, which underlies them rests on gneiss, hornblendic gneiss, schist, and quartz schist; and in the Mahanuddi River to the southward of the Talcheer coal-fields, which runs through the basic formations, a small amount of diamonds has been found. Where the Talcheer beds meet the hornblendic rocks by a fault on the Takiria River, and in the Ouli which flows to it from the Mahadeva rocks, gold is occasionally found.

North of this region the great Vindhyan rocks stretch across the country north-north-easterly, being the upper of three groups resting on gneiss and granite. These are described in the second volume of the "Memoirs of the Survey," by Professor H. B. Medlicott; and both he and Dr. Oldham give good reasons for placing the Vindhyan series in connection with the Damoodah, or coal measures, of the Talcheer field, and therefore they are far removed from the Bangnapilly beds belonging to the Mahadeva group to the southward.

Mr. Medlicott shows that the diamond beds are not all of one age, and instances the mines at Punnah, 600 or 700 miles north of Cuddapah, which he places close to the junction of the lower and middle groups of the Vindhyan series, at the northern edge of the Rewah tableland, in the shales, to which latter group they belong. This at once places them far below any possible jurassic or even triassic strata.

The Punnah diamond diggings occupy not more than 20 acres. The diamonds are found in a conglomerate belonging to relics of old spurs and outliers of the tableland. Fine grits among red and green shales, and a few beds of sandstone, constitute the strata.

At Kumerea (another field), the diamond bed is in an incoherent ferruginous sandy earth, of variable thickness and undecided position. To the east it is modified, and near Bridjepur it consists of two feet of conglomeratic sandstone, resting on strong beds of sandstone, and is worked at the surface. The "kukra," or diamond bed, is sometimes an incoherent ferruginous and sandy earth, variable in thickness and position as are the beds with which it is associated. It appeared to Mr. Medlicott to be somewhat of a puzzle where to place the conglomerate among the regular beds, and he considers the ferruginous element to be subsequent to the deposition. The beds thin out and thicken remarkably. The natives seem to have ascertained the limits of the diamond area, owing probably to the beds dying out. The base of the hills has not been tried.

As to the origin of the diamond, he does not think the stratum in which it is found is its native bed. He saw no diamonds *in situ*, but, from what he learned of the labourers, "*the diamonds came as pebbles with the rest.*" Quartz pebbles of any kind are rare. The most prominent pebbles are subangular red and white shale, and of what Franklin calls "green quartz," which is elsewhere described by Mr. Medlicott as "glazed or semi-vitrified sandstone." Pieces of the calcareo-siliceous bottom rock of the size of boulders occur also. One of the workmen confirmed his opinion, that the occurrence of these pebbles indicated the presence of the gem, and that "*they themselves contained diamonds, and were broken up*" as ore or, rather, as gangue.

In a section just north of the mines, twenty feet of regular beds of cherty and compact limestone rest on 50 feet of alternating sandstone and shale, based on rich sienite; the cherty and jaspery condition of some of the more vitrified beds is shown by another section to be due to a "modifying influence." It is supposed that these beds are the sources of the boulders in the diamond conglomerate. Besides these diggings, the great majority are said to be alluvial.

On the Rewa escarpment, in the Vindhyan region, they are at the heads of valleys descending from the plateau. where kunkery and lateritic clays pass into a mixture of clay, gravel, and boulders, increasing to great angular blocks of sandstone, between which the diamonds are found. Diggings occur also on the slopes. In one place men were seen removing 12 feet of dark brown clayey sand to get at the boulder bed, the base of which is richest.

"The limited distribution of the transported diamonds was more puzzling" to Mr. Medlicott than that of the rock. He thinks there are indications beyond the area that is worked.

The conclusion is, that the open valleys of Rewah are not altogether due to atmospheric and river action; the whole must have been under water when these diamonds were washed into their position. "If," says the author, "the diamond is but a pebble in the conglomerate," then, on the other hand, there is every chance of further discoveries, "since quartz grains of similar size with the diamonds are abundant, and there are other sufficient proofs of the recent submergence of the country."

In the above references there is not as clear a relation as was given in connection with Brazil; but the geology of the region is not in some respects so settled as to determine exactly where, in relation to other countries, the Vindhyan rocks of India belong. Enough, however, has been produced to show that the Mahadeva beds are younger than the Damoodah, which clearly correspond with our own upper coal-measures, and that the Vindhyan beds were faulted and elevated and denuded before the deposition of the Talcheer beds that are still lower than the Damoodah.

Under such circumstances it follows that there is probably no very close connection between diamond beds in India at distant localities, and very little to justify the supposition that all, if any, of the Indian diamond deposits can be exactly synchronous with older pliocene.

I have not yet mentioned two very important and interesting memoirs, by Messrs. Hislop and Hunter, published in the 10th and 11th volumes of the *Quarterly Journal of the Geological Society*, on the geology of the Nagpur territory. Differing in opinion from them as to the age to which they assign what they term the great jurassic formation, which extends over enormous areas. and comprises the coal-fields of Central India and Bengal, I would still accept their statements with the greatest respect. They regard the base of the Peninsula as formed of gneiss, granite, sienite, pegmatite, mica

schist, and quartz; but these are not all of anterior date to the sedimentary formations.

Over these occur the coal-bearing rocks, the upper part of which are the sandstones, partly transmuted, which have been already alluded to, and which other authorities regard as the source of the diamond.

Over these beds comes the lower trap rock, which is compact beneath and vesicular at the top, with cresting patches of nodular trap. These traps enclose in places a thin sedimentary formation of tertiary age, which has an uninterrupted range of 1050 miles in one direction, and of 660 miles in the other. Its age has relations with the eocene of Europe. Notwithstanding the order presented in various parts of this large region, the authors consider the various trap rocks as all younger than these beds, the lower having in fact been the younger. The trap, they hold to have flowed into and over and to have altered the lowest of these tertiary beds, which were deposited in a series of great lakes of no great depth.

Above the trap another series of beds occurs, the lowest of which is *laterite*, a well-known term to those who are conversant with Eastern Asiatic geology. In this, the authors state, occur the diamond mines east of Nagpur. They dispute the assertion that the diamonds belong to the transmuted sandstones below the trap; and say that at Weiragad (about 80 miles S.E. of Nagpur) there is no sandstone, but quartzose metamorphic rocks only. At that place the diamonds occur in a lateritic conglomerate, which overlies the sandstone in other places, and in which ferruginous cements occur formed from the detritus and boulders of adjoining formations; and this they hold to be the diamond conglomerate. It is therefore assumed to be younger than the overlying trap formation. Above comes in a series of deposits, the lowest of which is brown, the middle red, with existing fluviatile shells, land shells, and bones of mammalia (which Professor Owen has since determined to be those of buffalo and antelope); tusks of a large animal were also found in the brown clay. The uppermost deposit of all is the Regur or black cotton soil, in which kunkur is mixed. Bones of oxen and sheep are found in it.

Messrs. Hislop and Hunter consider these *black and red* clay beds to belong to the *post-pliocene* formations; the *brown clay* to the newer pliocene.

Assuming these Nagpur deposits to be correctly placed, diamonds of India are still, according to evidence collected from other authorities and already considered, traced to a conglomerate which may be more recent than our basalts on the Cudgegong, but may not be more recent than those at Ballarat; but which seems to have derived its pebbles and boulders from palæozoic and metamorphic and ordinary igneous rocks; *laterite* itself covering rocks alike of every older epoch. Occurring as this detrital *covering* does all over India, and having the same relative position to all kinds of rocks, and at all heights up to that of at least 8000 feet above the sea, the idea of diamond belonging to it as its actual source is not sustainable.

In a subsequent paper (*Q. J. G. S.*, vol. xvi.) the Rev. S. Hislop, one of the authors, considers the intertrappean tertiary bed as lower eocene, producing good fossiliferous evidence for this opinion; and shows that the Mahadeva or Bangnapilly sandstone is about the same age, in which Dr. Oldham seems to coincide. ("Memoirs of India," vol. i., p. 171). Hislop's views have not been thoroughly received by other geologists; and doubts have been expressed as to whether the trap or basaltic formation of India is not all of one age.

If compared with the Cudgegong diamond deposits, the older of which, and from which the younger is derived, underlies the trap (basalt), it will be seen there is a difficulty to be reconciled with respect to each; and if the diamond conglomerate of India be lower eocene, that difficulty is complicated by assuming that the Cudgegong deposit is pliocene.

On reviewing the whole evidence I am inclined to believe that unless they are much younger than the the pliocene or pleistocene epochs, in fact of recent origin, they must be considered as drifted from rocks older than the carboniferous. As they everywhere exist in limited areas, it would also be a fair inference that as there is no want of carbon, and similar agencies must operate over enormous regions, the limited range of diamond is a strong argument against its recent production. If the facts advanced by several of the authorities whom I have quoted are received, then diamond must have undergone processes similar to those that have resulted in the formation of gems, of which there is no dispute as to probable age.

It is remarkable how silent observers in general in India are as to the multiplicity of such gems and other extraneous minerals in the Indian diamond regions. Yet Mr. Carter names quartz, jasper, Lydian stone, epidote, micaceous iron, garnets, and corundum, derived from rocks of different ages.

There is another interesting locality near Gungpur, on the northern frontier of Orissa, on a river running to the Bay of Bengal, north of Kuttak; but I have no accurate knowledge of its history.

To these remarks on Indian diamond beds I have only to add, that in 1867, I had the honour of a visit from an officer of the Bengal army, whose official position gave him great opportunities of acquaintance with the country, and who came to this colony on a tour of inspection, to examine our railways and coal-beds, and from him I learned that the Vindyhyan conglomerate is chiefly made up of jasper, chalcedony, specular iron, and a green rock, which latter lies *en masse* on granite; that the diamonds are of all colours—rose, yellow, brown, black, and *pale green*—which last being the favourite, or national colour of the followers of Mahomet, causes the green diamond to find a ready sale, whilst the others are neglected. In size they are that of a hazel nut, or larger. But, he added, that in the diamond districts the people are wretched; they think and talk of little but diamonds, which they often swallow if not watched.

(To be continued.)

ON THE ESTIMATION OF SULPHUR BY BARIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

(Concluded from p. 62).

In each of the preceding experiments the *modus operandi* was the same; the precipitation being effected when both solutions were boiling, a dense arenaceous precipitate fell, which was most easily and quickly washed. Boiling water only was used for the first washings, so as to induce the solution of any adherent chloride of barium, then diluted and hot hydrochloric acid to remove any other possibly adherent salt, finally, boiling water only; the precipitate then was collected on a filter, and washed until the filtrate was not affected by a solution of silver. The precipitate was dried and then ignited on porcelain, first of all gently, and then to redness over a Bunsen burner, the filter-paper being burnt separately, and the weights added together in the usual mode. In every instance, the ignited sulphate was a pure white and soft powder, yielding both chlorine and barytes to water, and still more barytes when treated with diluted nitric acid.

In one instance only throughout the above experiments does the weight of the sulphate obtained fall below the calculated amount; in all the others it is above it, varying from about ½ to more than 2 per cent in excess, and this when the perfect freedom of the ignited sulphate from the iron base is made evident by its whiteness. So it is clear, despite the especial pains taken to free the precipitate from any adherent salt, that, in eight out of the nine experiments, barium, in some form, has combined with the precipitated sulphate, and thus brought about an increase of weight, when, but for this, from the solubility of the

sulphate in hydrochloric acid, there ought to have been a deficiency.

Although, from experiments which preceded those just described, but which it will be more convenient to consider hereafter, as well as from long practice, we could safely rely on crystallised sulphate of iron as being of an uniform, constant, and definite composition, we thought it well to substitute another sulphate for it, so as to ascertain whether we should be equally at sea with it as with the ferrous sulphate. Accordingly, we fixed on crystallised sulphate of magnesia, which may readily be obtained pure and containing its exact amount of water of crystallisation, several determinations yielding 51·20 per cent of water, which is the calculated quantity. Of this salt, 96·10 grs. is equal to 12·50 grs. of sulphur, or 91 grs. of sulphate of barytes, and proceeding as above described, only replacing the iron by the magnesium salt, we obtained from 96·10 grs. of sulphate of magnesia—

No. 1.	93·00	grs.	of sulphate	of barytes.
,, 2.	92·15	,,	,,	,,
,, 3.	92·60	,,	,,	,,

and in each case the ignited sulphate yielded chlorine, magnesia, and barytes to water and to acid. It was obviously useless to multiply these experiments, as, although the range of difference is not so great as with the iron salt, yet the weight of sulphate is always in excess, and this sufficiently marked as to confirm us in distrusting the estimation of sulphur by barium.

Our next step in this investigation was to determine the weight of sulphate of barytes yielded by 108·60 grs. of crystallised sulphate of iron after oxidation, as in the estimation of sulphur in pyrites, in other respects following the process already described.

No. 1.	89·70	grs.	of sulphate	of barytes.
,, 2.	87·05	,,	,,	,,
,, 3.	90·10	,,	,,	,,
,, 4.	89·70	,,	,,	,,
,, 5.	89·40	,,	,,	,,
,, 6.	88·90	,,	,,	,,
,, 7.	90·80	,,	,,	,,
,, 8.	91·00	,,	,,	,,
,, 9.	90·00	,,	,,	,,

Here the reverse of the preceding experiments obtains; in no case is there an excess of weight of the precipitate—in one instance only does it amount to the calculated weight which, in the other eight examinations, is never attained; indeed, this loss is so constant, yet so variable in amount, as to prove that the gravimetric method of estimating the sulphur in pyrites must be abandoned. This loss is the more worthy of remark from the discolouration, in every instance, of the precipitate by oxide of iron, the colour varying from buff to a deep salmon tint; and, also, which seems to be invariable, the presence of chlorine and barytes soluble in water and acid in all the precipitates, so that the actual loss of sulphate is, in every case, even greater than the apparent loss.

This would have been more evident had we not thrown away the filtrates and washings of the first six of the preceding experiments before we bethought ourselves that it was desirable to ascertain whether any sulphate of barytes was held in solution; however, on mixing the filtrates and washings of the three last, and evaporating, we obtained 4·20 grs. of sulphate of barytes, which, added to the precipitates, and averaged, shows the adherent salt to have amounted to 1 gr. in each instance, and to a loss of 1·40 grs. of sulphate of barytes in each experiment. He must especially dwell on this customary deficiency of sulphate of barytes when precipitated from an acidified solution of a soluble sulphate as casting the gravest doubts on the trustworthiness of all analytic results thus obtained, and even leading to but widening error, when the resultant sulphate has been purified from its adherent salts by subsequent treatment with dilute acids.

As our aim in these remarks is, not only to prove the futility of relying on the ordinary methods of estimating sulphur by barytes, but especially their worthlessness as applied to pyrites, we followed the foregoing experiments with three more in duplicate, on a sample of pyrites which we have already ascertained contained 49 per cent of sulphur. 25 grs. of this pyrites, which ought to yield 89·20 grs. of sulphate of barytes, oxidised in the usual manner, but the solution not evaporated to dryness, and, therefore, containing some nitric acid, yielded 90·10 grs. of sulphate of barytes, when the filtered solution and washings were precipitated, by 120 grs. of crystallised chloride of barium, from the boiling solution, this left to cool, and the resulting sulphate washed with diluted and hot hydrochloric acid, and then with hot water till free from chlorine. This 90·10 grs. of sulphate of barytes indicates 49·50 per cent of sulphur. The filtrate and washings of this precipitate yielded 1·10 grs. of sulphate of barytes when evaporated, which, added to the weight of the precipitate, indicates just over 50 per cent of sulphur in this sample of pyrites, or an error in excess of 1 per cent of sulphur. Of the 90·10 grs. of this ignited precipitate, 80 grs., when boiled with diluted hydrochloric acid, washed, collected, and ignited, yielded 78·40 = 88·30 grs. on the whole amount, indicating 48·50 per cent of sulphur. This experiment exactly repeated, yielded 90·50 grs. of sulphate = 49·70 per cent sulphur. Filtrate and washings gave 1·05 grs., which, added to the above, indicates 50¼ per cent of sulphur. Of the ignited precipitate, 80 grs. when purified left 78·20 grs. = 88 grs. on the whole amount, or rather less than 48¼ per cent of sulphur.

Another 25 grs. of pyrites were oxidised, and the solution evaporated to expel nitric acid, then re-dissolved in about 200 grs. of hydrochloric acid, and solution and washings treated as in the foregoing experiments. The ignited sulphate weighed 88·80 grs. = 48·78 per cent of sulphur. The filtrate &c., in this instance left 0·70 gr. of sulphate; and 80 grs. of the ignited precipitate, treated as above with dilute acid, left 78·50 = 87·15 grs. on the whole amount, or 47·87 per cent of sulphur. This experiment also exactly repeated gave 87·30 grs. sulphate = 47·88 sulphur. 80 grs. ignited sulphate when purified left 78 = 85·10 grs. sulphate on the whole, or 46·75 per cent of sulphur. Flitrate and washings left 1·50 grs. sulphate of barytes.

Again, 25 grs. of this pyrites, oxidised, evaporated, and re-dissolved in 700 grs. of hydrochloric acid, and then proceeding as above, only washing the precipitate with but slightly diluted acid in the first instance, yielded 88·80 grs. of ignited sulphate = 48·78 per cent of sulphur: and 80 grs. when purified left 77·90 or 86·50 grs. on the whole amount = 47·50 per cent of sulphur. Filtrate, &c., left 1·60 grs. of sulphate of barytes. This experiment also when exactly repeated gave 89·35 grs. of ignited sulphate = 49·10 per cent sulphur. This, purified, yielded 87·35 grs. on the whole amount, or 48 per cent of sulphur, filtrate and washings being equal to 1·60 grs. of sulphate.

Let us tabulate the final results in sulphur of these experiments—column A indicating the percentage of sulphur calculated from the original precipitate. Column B, this, *plus* the deposit yielded by the filtrate and washings, and C the percentage of sulphur on the assumed purified precipitates.

A.	B.	C.	
49·50	50·00	48·50	per cent of sulphur.
49·70	50·30	48·45	
48·78	49·16	47·87	
47·88	48·78	46·75	,, ,,
48·78	49·66	47·50	
49·10	50·00	48·00	,, ,,

Columns A and B are often near to the truth, or 49 per cent of sulphur; the error from the solubility of the sulphate being nearly or more than compensated by adherent impurity; but when the sulphate is subjected to subsequent treatment as in column C, the wide departure

of the results from the truth, and consequent invariable deficiency and error by loss of sulphur, is manifest. Indeed, as we have shown before, this purifying process is unending, all these purified precipitates again yielding barytes on treatment with diluted acids.

We think those readers who have followed us thus far will admit that we have proved the estimation of sulphur and sulphuric acid by the weight of the sulphate of barytes obtained is, and can be, correct only by accident, and when the adherent impurity happens exactly to counterbalance the sulphate dissolved. That sulphate of barytes, when precipitated from a solution by an excess of a soluble barytic salt, invariably takes down with it some of the precipitant, and often salts of other bases which may be present in the solution, and thus vitiates the results. That sulphate of barytes, when ignited over a gas-flame, is always reduced to a noticeable extent. That if it be attempted to purify such sulphate from the adherent salts, that the results are always and still further erroneously affected, and that sulphate of barytes is notably soluble in water acidified by hydrochloric acid, and this to an extent sufficient to falsify all results.

Although the foregoing series of experiments are recent, the facts they point to have long been known to us, and have gradually led to a method of estimating sulphur by barium, more especially the sulphur in pyrites, which experience and continuous use have proved to us to be exact, reliable, and to yield constant results. This method we shall now, in concluding these remarks, endeavour to describe in detail, requesting the patient attention and consideration of our readers for the difficulty we feel in conveying a lucid description of a process which necessarily involves some practice and judgment on the part of the operator to ensure both rapidity in working and correctness of results, although these are assured when once the practical details of the method are mastered.

This method is based on five conditions, viz.—

The use of a standard solution of chloride of barium, *by weight.*
The complete oxidation of the sulphur, and subsequent expulsion of all the nitric acid.
The avoidance of a large excess of hydrochloric acid in the solution.
The avoidance of large quantities of solutions.
The use of considerable weights of pyrites in testing, thus avoiding the extreme of multiplication of any analytical error in the percentage return.

The preparation of the standard solution of chloride of barium, now that this salt is met with in commerce so pure and definite in composition, offers no difficulty and requires no details from us, excepting that we find it convenient in practice and for the sake of the ready calculation of results that 1000 *grs. by weight* of this solution shall be equal to and represent *25 grs. of sulphur.* It is advisable to use water just acidified with hydrochloric acid in making this solution, to prevent the deposition of carbonate of barytes, which often occurs when the standard solution is kept.

To prove the correctness of this standard solution it is not enough to precipitate known weights, collect, and weigh the resulting sulphate, as these results slightly vary, but it is advisable thus to check the solution as a confirmatory measure by repeated tests, adding, say, 1000 weighed grs. of the standard solution, heated nearly to boiling, to a boiling solution of diluted sulphuric acid containing an excess of acid, when the sulphate of barytes obtained yields traces only of chlorine to water after ignition; but if this order be reversed, and the diluted sulphuric acid is added to the solution of chloride of barium, so that this latter is in excess, until complete precipitation is effected, then the sulphate of barytes will be found to yield abundant evidences of chloride of barium when treated with water after ignition. In any way of testing this standard solution the results will, however, closely approximate to the truth, since in seven tests of the standard solution 1000 grs. yielded 181·40 grs. as the lowest, and 182·30 grs. as the highest weight of ignited sulphate, whilst 181·95 grs. is the average of these seven tests, the calculated weight being 182 grains. This average exactness is in great measure due to the insolubility of sulphate of barytes, in a solution wherein free sulphuric acid is present. Although the error of this test, either way, is but slight, still it is error; so that it is advisable to rely on the crystallised sulphate of iron already described as the ultimate and final test of the accuracy of the standard solution of chloride of barium. Thus, 108·60 grains of this salt = 12·50 grs. of sulphur, is dissolved in about 1000 grs. of water slightly acidified with hydrochloric acid, and heated nearly to boiling; to this is added standard solution of chloride of barium somewhat below the estimated weight, say, 490 to 495 grs., also heated, stirring all the time, and then boiling rapidly. A small portion of the solution is then filtered and the standard solution added, drop by drop, to the filtrate, which must be returned to the test liquor and boiled at each testing until a filtrate is obtained, which, after standing, just clouds both with dilute sulphuric acid and the standard barium solution. In practice it will be found that a standard solution is readily obtained, 500 grs. of which treated as above with 108·60 grs. of crystallised sulphate of iron will yield a filtrate manifesting slight cloudiness both with barytes and sulphuric acid, and which with a deficiency of 2 grs. in the test of the standard solution will yield a marked precipitate on the addition of the 2 grs. to the filtrate, and an equally well-defined reaction with dilute sulphuric acid when 2 grs. in excess of the standard solution of barium has been used. The operator will naturally make sufficient standard solution for some six or twelve months' consumption; but this should not be tested and rectified until it has been made for some forty-eight hours, and then no pains must be spared to ensure its accuracy and exact adjustment. Thus, in addition to the weight of sulphate spoken of above, the average of which was 181·95 grs., the estimated weight being 182 grs., we find the required weight of our standard solution of chloride of barium, when controlled and verified by the already-named weights of crystallised sulphates of iron and of magnesia, equivalent to 12·50 grs. of sulphur, in eleven consecutive tests to be 501, 501, 500, 501, 500, 499, 499, 500, 500, and 500 grs. and with such testing we are satisfied of the reliability of the standard solution, and rest content; merely taking the precaution to re-test from time to time, as when opening a fresh Winchester quart, so as to prevent mistakes of any kind creeping in.

We may be forgiven for insisting at such lengths on ensuring the rigid accuracy of the standard solution of barium, as this is essential to correctness of results; and we now turn to the Estimation of Sulphur in Pyrites. When the sample to be tested occurs in lumps, the whole must be broken down and passed through a sieve of about 120 meshes to the square inch, then thoroughly mixed, turned out on paper, and spread out to an uniform but shallow depth, portions being now taken from various parts with a scoop or laboratory knife, returned to a hard porcelain mortar, and ground still finer. From this another portion is taken in a similar manner and again ground in the usual way. Of this from 100 to 200 grs. are again taken, and ground as finely as possible, and then dried on a water-bath at 212° F. It is essential, and this most especially with the poorer crystalline ores, that this test-sample be reduced to an impalpable powder. Of this test-sample, carefully but rapidly dried, let two portions of 25 and 30 grs. each be weighed and placed in separate flasks with long necks, and of from 16 to 20 ozs. capacity; the flasks being previously damped inside with a few drops of distilled water so as just to moisten the pyrites, and then loosely closed by placing small funnels in their mouths. A mixture of some 50 grs. of hydrochloric acid and 150 of nitric acid, sp. gr. 1·40, by measure, is then to be poured into each flask, but not directly upon the ore, and immediately a quick rotary motion given to the flask, so as to rapidly mix the ore and

acid, which may and ought to be effected and the flask placed on a ring in an oblique position, before action takes place. Action rapidly and energetically ensues, and so soon as it ceases, add 200 grs. of additional hydrochloric acid, place the flask on sand or hot plate for evaporation, which is to be carried *just to* dryness, a point which demands care and watchfulness to hit; 100 grs. more hydrochloric acid is then added to the flask to re-dissolve the contents. Now is the time to detect whether the oxidation of the sulphur is complete or no, as the merest trace of free sulphur may be recognised in the flask by the eye; and, if so, then reject the experiment and begin *denovo* on fresh portions of the test-sample still more thoroughly ground.

A small flask holding some 1000 grms. of standard solution of chloride of barium, with dropping tube, is now counterpoised, and so much of the solution transferred to a porcelain basin as practice shows may be looked for as nearly equivalent to the strength of the pyrites in sulphur.

The requisite quantity of standard solution is a point which must be left to the experience and judgment of the operator; thus, with the best Spanish ores we start with 480 to 485 grs. of standard solution to the 25 of pyrites; with other amorphous ore, 450 grs. is an average amount; whilst with crystalline pyrites 350 to 410 grs. of standard solution is sufficient to start with. Whatever the amount may be, it is to be heated nearly to boiling and poured into the test-solution of the pyrites, having previously washed the neck of the flask and funnel with hot water to carry down any adherent splashes; then the whole returned to the basin from the flask, which must be repeatedly washed with small quantities of water and added to the solution in the basin, taking care that the whole of the solutions and washings shall not exceed in bulk 1500 measured grs. of water. Now boil rapidly, and having a small damped filter ready, filter a little of the mixed solution, and add a portion of the filtrate to about 3 or 4 grs. of standard barium solution placed, from the counterpoised flask containing it, in a test-glass. Should a further precipitate be produced, this tested solution is to be returned to the basin with the rest of the filtrate, and so much more standard solution of barium added as in the judgment of the operator is required, this is again boiled and filtered, using the same filter, and tested as before, repeating this operation until a precipitate ceases to appear with the standard barium solution, when the weight of the solution employed is to be taken and noted. When this point is arrived at, a portion, some 3 or 4 grs., of a standard dilute sulphuric acid, which it is convenient to have equivalent to the standard solution of barium, weight for weight, is to be placed in another test-glass, and a little of the filtrate poured upon it. Should this not yield a precipitate, or should both barytes and sulphuric acid show a cloudiness only on standing for a few minutes, the operation may be pronounced complete, and the test confirmed by proceeding with the second test-solution of the pyrites as above, but adding at once the exact and ascertained weight of the standard barium solution. Should this, also, on testing, confirm the first test, and the filtrate yield evidence neither of barytes nor sulphuric acid, we regard the estimation as complete; the amount of sulphur being easily calculated from, and confirmed by, the weights of standard solution of chloride of barium employed, which should agree within 1-500th, or the operator have recourse to a third test or more, until he is satisfied of his correctness.

When too much chloride of barium solution has been added in the first instance, and consequently a precipitate obtained with standard sulphuric acid, the filtrate is returned to the basin, and boiled with gradual additions of the standard sulphuric acid until the point is attained when neither barytes nor sulphuric acid causes a precipitate, so that the chloride of barium in excess may be deducted from the weight used in the first instance; but it is well to test the pyrites under examination a third time, and to employ the result of this first test as a guide only to the actual test and re-test on which the operator intends to rely when he has overshot the mark and added an excess of standard barium solution in the first instance. We must be allowed to recommend that in all cases when the operation approaches completion, the filtrate, after the addition of barium solution or sulphuric acid, should be allowed an interval of two minutes before testing it the reverse way.

Estimated by the method we have thus endeavoured to describe, the amount of sulphur in pyrites may be determined with accuracy and certainty to a 1000th part or 1-10th per cent; and the sulphuric acid present in any solution may thus be estimated with ease, taking care to avoid too great dilution of the sulphate.

It may be as well to add, that 108·60 grs. of sulphate of iron = 12·50 sulphur, oxidised as in the above-described method, required, in five consecutive experiments, 500 and 501 grs. by weight of the standard barium solution, the filtrate either remaining transparent or slightly clouding with both barium and sulphuric acid; thus proving that no loss of sulphur is sustained by oxidation. It is seldom the difference between the original and confirmatory test of a sample of pyrites exceeds 0·10 per cent, whilst they usually agree. Also, that the crystalline pyrites, of which the Norwegian ore is a type, is apt to deposit free sulphur during oxidation, unless most carefully ground; so that, with such ore, this point must be more carefully looked to than when amorphous samples, like most Spanish ores, are valued.

We have now only to state that, whilst the mode we have endeavoured thus to bring into notice is far more rapid than the gravimetric method of estimating sulphur, the results are so constant and reliable that, should it meet with general adoption and use by those interested in the subject, we feel assured the differences in estimating the value of pyrites, and consequent disputes which have caused so much annoyance to ourselves and others, will cease to exist.

NOTE.—Dr. Noad has obligingly called our attention to his comments upon some observations of Mr. Calvert, "On the Solubility of Sulphate of Baryta in Acid Liquors;" wherein that author says, "The insolubility of this salt is affected even by the weakest nitric or hydrochloric acids, and that in future the practice of rendering liquors acid with either of these acids must be discontinued when sulphates are to be determined." Dr. Noad, in this paper, which may be found in the *Quarterly Journal of the Chemical Society*, vol. ix., p. 15, most strongly insists on the fact, that sulphuric acid may exist in the nitric acid of commerce without the production of a precipitate on the addition of a soluble salt of barytes; thus furnishing another probable source of error in estimating the amount of sulphur present in pyrites.

As we read the remarks of Dr. Noad, we find our observations on the solubility of sulphate of barytes in solutions acidified by hydrochloric acid fully confirmed by his experiments; and that "the solubility of sulphate of baryta in a large bulk of dilute hydrochloric acid" has been conclusively proved by himself and confirmed by us, although we must beg leave to differ from him in his conclusion, "that in a practical point of view it is of no importance," as, so far as our experience goes, whether the hydrochloric acid used be strong or dilute, sulphate of barytes is always dissolved in the acid solution; and that a considerable excess of the soluble barytic salt only tends in some measure to counterbalance the loss sustained by solution of the sulphate, by its adhesion to the precipitated sulphate of barytes, forming therewith a compound insoluble both in water and dilute acids. And, consequently, we re-affirm, "that we have proved the estimation of sulphur and sulphuric acid by the weight of the sulphate of barytes obtained is, and can be, correct only by accident, and when the adherent impurity happens exactly to counterbalance the sulphate dissolved."

NOTICES OF BOOKS.

The Retrospect of Medicine: Being a Half-Yearly Journal containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Lond. Vol. lxiii., January—June, 1871. London: Simpkin, Marshall, and Co. Edinburgh: Oliver and Boyd. Dublin: Hodges, Foster, and Co.

THE advent of these well-known volumes edited by Drs. Braithwaite must be welcome to the hard-worked medical man who has little time to read up in cases not immediately presented to him. The volume for the past half-year fully continues the high character of those already issued.

Among the many valuable papers that "On a Rapid and Accurate Method of Milk Analysis; with a special reference to the Examination of Woman's Milk," by Dr. Muter, the Director of the South London School of Chemistry and Pharmacy, is by no means the least interesting. He says:—"After many trials in various directions, it was determined to base the analysis on the real dietetic value of the milk, as represented by a determination of its solid residue and the estimation of its nitrogenous and carbonaceous constituents. Experience derived from the use of Dr. Frankland's elegant system of water analysis by combustion *in vacuo* led ultimately to the application of a similar principle to milk. The process, when used for cow's milk, requires several modifications, in view of possible admixture with certain extraneous matters. The process is conducted as follows:—A small paper filter is prepared which will contain 10 grms. of oxide of copper. It is filled with the oxide and placed in a small funnel. The whole is then exposed for an hour in an air-bath, so constructed as to draw a continuous current of air at 105° C. through and around the funnel. The funnel and its contents are then cooled in the desiccator, and weighed with great care, and the weight having been noted, *five drops* of the milk are cautiously let fall on the centre of the oxide, taking care that no milk spreads to the filter paper. The whole arrangement is then weighed, and the quantity of milk used found by difference. The funnel and contents are then replaced in the air-bath, and exposed to a temperature gradually increasing from 50° to 105° during several hours. When the milk has been thus dried it is again weighed at intervals until it ceases to lose weight. This loss of course shows the percentage of water, and, consequently, of the total solids. The contents of the filter are now transformed to a warm glass mortar, mixed with more oxide of copper and introduced into a combustion-tube. The tube is charged in the usual way, but the front part is filled through 3½ inches of its length with a roll of copper gauze previously ignited in hydrogen. The end of the combustion-tube is then drawn out before the blowpipe, and connected by an india-rubber and glycerine joint to the Sprengel air-pump. Heat is now applied to the front part of the tube, and, the air having been fully exhausted, the combustion is proceeded with, and the residual gases received into a tube over mercury. At the close of the combustion the gases are entirely transferred from the combustion to the receiving tube by the aid of the pump, and it now only remains to measure them in a manometric apparatus. The gases are first measured as a whole, and then separately absorbed by the usual reagents and measured after each absorption. We thus obtain the total volumes of carbon dioxide and nitrogen evolved by the milk-residue, and by a simple set of calculations we are enabled to deduce the actual weight of carbon and nitrogen contained in it, and consequently its exact value in nutriment. In one continued series of operations we therefore ascertain (1) the total solids, and (2) the amount of their flesh-forming and heat-producing constituents. When thus complete, the analysis would be expressed as follows:—

Amount of milk taken, 0·24 grms.
Total solids, 0·0264 = 11 per cent.
Organic nitrogen .. .. 0·0014 = 0·5833 per cent.
" carbon .. .. 0·0167 = 6·5420 "

Therefore—

Water	89·00
Flesh-formers (casein)	3·71
Heat-producers (fat and sugar)..	7·29
	100·00

This is a good specimen of well-balanced healthy milk."

The clinical value of such a plan of analysis it would be difficult to over-estimate, especially as the quantity of milk required is so small as to be easily procurable at any time.

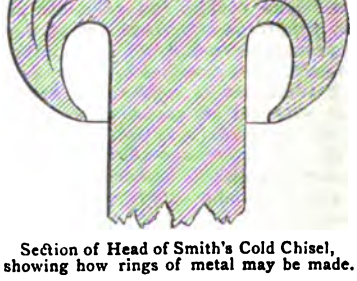
There is another very interesting extract on a Method of Embalming the Dead. Embalming seems in many cases desirable, not only as a sanitary precaution in large towns, where, as in Edinburgh and Glasgow, the dead are placed in family vaults situated in the very heart of the city, but as being of service to the anatomist, and enabling those whose relatives have died away from home to procure the body in a state presenting hardly any post-mortem change. Dr. Vivodtsef's process is simple, short, and easy of accomplishment, consisting merely in the injection of a mixture of carbolic acid and alcohol into the arteries by means of Dr. Richardson's apparatus for local anæsthesia, the quantity of the mixed fluid equalling about one-half the weight of the body. But these papers are not of exceptional interest, and very lengthy extracts would have to be made to do justice to the editors' happy compilation.

CORRESPONDENCE.

RING VORTICES.

To the Editor of the Chemical News.

SIR,—IN the *Philosophical Magazine* for 1864 will be found two papers by Mr. Charles Tomlinson, on figures of this kind, which he calls "submergence cohesion figures." His experiments are exceedingly numerous and interesting, well worth study, and relate mainly to oils. He gives his



Section of Head of Smith's Cold Chisel, showing how rings of metal may be made.

views of the causes of the formation of these rings in these words:—"Take the case of a liquid ring. The forces are (1) *diffusion*, which forms the ring; (2) *gravity*, which causes it to sink. The resistance is *friction*, retarding (1) the descent of the ring, (2) its diffusion."

It will be seen I differ from Mr. Tomlinson as to the causes, and especially as to the correlation, of these phenomena. I think the "ring" is due to the ordinary motion following from the impact of two bodies, just as the smith's chisel head is "burred" out and recurved by

blows, showing the commencement of a cold metal "ring." The *descent* is due mainly to the initial velocity of the drop, and although diffusion may modify, and so, in one sense, may be said to create these phenomena, yet it really is the cause of their destruction. Finally, I think the ordinary laws of motion applied to streams of fluids impacting on other matter is sufficient to account for nearly all the phenomena. Least of all, I think, is the effect of cohesion on such "rings" as I am considering, viz., those formed in similar fluids by one small portion moving at greater velocity than another, *i.e.*, by impact. This is clearly shown also, I think, by the influence exerted on these phenomena by the area of the receiving vessel.—I am, &c.,

HENRY DEACON.

Edinburgh, August 5, 1871.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following is a complete list of the papers which were brought before Section B (Chemical Science) at the Edinburgh Meeting, under the presidency of Dr. Andrews, F.R.S., &c. They will be published, in full or in abstract, according to their importance, in the CHEMICAL NEWS:—

The President's Address.

J. Dewar.—*Preliminary Report on Thermal Equivalents of the Oxides of Chlorine.*

J. H. Gladstone and Alfred Tribe.—*Some Experiments on Chemical Dynamics.*

Charles Tomlinson.—*On the Behaviour of Supersaturated Solutions when Exposed to the Open Air.*

Thomas Ainsworth.—*Facts developed by the Working of of Hæmatite Ores in the Ulverstone and Whitehaven Districts from 1844 to 1871.*

C. Gilbert Wheeler.—*Recent Progress in Chemistry in the United States.*

Henry Deacon, J.P.—*Deacon's Chlorine Process as applied to the Manufacture of Bleaching Powder on the larger scale.*

T. L. Phipson, Ph.D.—*On Regianic Acid.*

Dr. Crace Calvert.—*On the Estimation of Sulphur in Coal and Coke.*

E. C. C. Stanford.—*On the Retention of Organic Nitrogen by Charcoal.*

J. Smyth.—*Improvements in Chlorimetry.*

W. Delffs.—*On Sorbit.*

Emerson Reynolds.—*On the Action of Aldehyde on Sulpho- and Oxygen-Ureas.*

Emerson Reynolds.—*On the Analysis of a Singular Deposit from Well-Water.*

W. Chandler Roberts.—*The Molecular Arrangement of the Alloy employed for the British Silver Coinage.*

T. Moffat.—*On Ozonimetry.*

Dr. Andrews.—*On the Dichroism of the Vapour of Iodine.*

Dr. Andrews.—*On the Action of Heat on Bromine.*

Dr. O. Richter.—*On the Chemical Constitution of Glycolic Alcohol and its Heterologues, as viewed in the new light of the "Typo-Nucleus" Theory.*

Report of the Committee on the Utilisation of Sewage.

Dr. Bischof.—*On the Examination of Water for Sanitary Purposes.*

Mr. Weldon.—*On a Proposed Method of Recovering the Sulphur Employed in the Manufacture of Soda.*

Abbé Moigno.—*On the Photographic Post.*

Dr. Thorpe.—Contribution to the History of the Phosphorus Chlorides.

Mr. Pattison Muir.—*On an Antimony Ore from New Zealand.*

Mr. John Dalzell.—*On Sulphur Dichloride.*

Dr. Wright.—*On the Oxidation Products of the Essential Oil of Orange-Peel.*

Dr. Wright.—*On some New Derivatives from Codeia.*

Dr. Delffs.—*On a Modified Method of Testing for Morphine.*

Mr. Tichborne.—*On the Dissociation of Molecules by Heat*

Mr. J. Y. Buchanan.—*On the Rate of Action of Caustic Soda on a Watery Solution of Chloracetic Acid.*

Mr. Hope.—*Experiments on Britton's Farm.*

Dr. Corfield.—*Comparison of Results during Winter of Croydon, Norwood, and Britton's Farm Experiments.*

Dr. Corfield.—*Report on Analysis in connection with above.*

Dr. Corfield.—*Upward Filtration of Sewage at Ely.*

Dr. Corfield.—*Phosphate Process.*

Drs. Corfield and Gilbert.—*Dry-Earth System at Lancaster.*

Report of the Committee appointed for the purpose of Superintending the Publication of Abstracts of Chemical Papers.

Prof. Apjohn.—*Some Remarks upon the Proximate Analysis of Saccharine Matters.*

Dr. Gladstone.—*On Crystals of Silver.*

Mr. Braham.—*On the Crystallisation of Metals by Electricity.*

Mr. J. S. Holden.—*On the Aluminous Iron Ores of County Antrim: their History and Composition.*

Prof. Maskelyne.—*On Dufrenite and a New Mineral from Cornwall.*

Prof. Maskelyne.—*On Localities of Dioptase.*

Dr. Goodman.—*Note on Fibrin.*

Rev. H. Highton.—*On a Method of Preserving Food by Muriatic Acid.*

Mr. Wanklyn.—*On the Constitution of Salts.*

Mr. Harkness.—*Preliminary Notice on a New Method of Testing Samples of Wood-Naphtha.*

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University of London.—The following are lists of the candidates who have passed the recent First B.Sc. Examination.—*Pass Examination.* (First Division).—Robert William Atkinson, University College, and Royal School of Mines; Frederick Douglas Brown, Royal College of Chemistry and private study; Thomas Carnelley, Owen's College; Robert Moses Lewis, B.A., Downing College, Cambridge; Hugh William McCann, Liverpool Institute; John Henry Poynting, Owen's College; James Richmond, Manchester Grammar School; Thomas Hutchinson Waller, B.A., private study. (Second Division).—Charles Callaway, M.A., Cheshunt College; Baron Armand De Watteville, M.A., University College; Charles William Huson, Queen's College, Liverpool; Alexander Irving, B.A., private study; Leander Starr Jameson, University College; Charles Coleman Jewell, University College; George Lewis, B.A., King's College and private study; Martin Stewart, Queen's College, Birmingham; John Foster Trafford, University College.

Quekett Microscopical Club.—The sixth annual meeting of this club was held on Friday evening, July 28th, at University College. By the annual report of the Committee read, it appears that the number of members now amounts to 550. The President, Dr. L. S. Beale, gave the annual presidential address. At the election of officers which followed, Dr. L. S. Beale was elected President for the year 1871-72; for Vice-Presidents, Dr. Robert Braithwaite, F.R.M.S., F.L.S., Mr. Arthur E. Durham, F.R.C.S., Mr. Charles J. Leaf, F.R.M.S., Mr. Henry Lee, F.Z.S.; for four Members of Committee, Messrs. W. H. Golding, T. Greenish, E. Marks, and F. Oxley; for Treasurer, Mr. Robert Hardwicke, F.L.S.; Hon. Secretary for Foreign Correspondence, Mr. M. C. Cooke, M.A.; Hon. Secretary, Mr. T. Charters White, M.R.C.S. The meeting then terminated in the usual *conversazione*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 12, 1871.

This number contains the following original papers and memoirs:—

Disulphobenzoic Acid and a New Dioxybenzoic Acid.—L. Barth and C. Senhofer.—Benzoic acid, having been placed along with anhydrous phosphoric acid and strong sulphuric acid, into a sealed tube, and heated to 250°, has yielded disulphobenzoic acid—

$$C_6H_3\left\{\begin{matrix}COOH\\SHO_3\\SHO_3\end{matrix}\right\}+H_2O.$$

This body is very hygroscopic, and retains some water even at 130°. The salts of this acid are crystalline substances. When the potassa salt is fused with excess of caustic potassa, and the fused mass treated, after cooling and acidulating, with ether, the latter takes up a new acid, to which the authors give the name of dioxybenzoic acid. This substance crystallises in prismatic shape, and is characterised by not yielding (as protocatechutic acid, which is isomeric with this new acid, does) a green colouration with chloride of iron, and not being precipitated by acetate of lead. The dioxybenzoic acid fuses at 220°, but is partially decomposed at that temperature; its formula, in the air-dry state, is—

$$C_6H_3\left\{\begin{matrix}COOH\\OH\\OH\end{matrix}\right\}+1\tfrac{1}{2}H_2O.$$

At 105°, this acid loses its water of crystallisation; heated with strong sulphuric acid, it is converted into a red-coloured fluid, which, by the addition of water, yields a green-coloured precipitate. The salts of this dioxybenzoic acid are crystalline substances. On being submitted to dry distillation, this acid does not yield any of the well-known bihydroxyl-benzols. The authors are engaged with further experiments on the nature of the substances formed by the operation alluded to, and also with researches on the nature of the substance produced by the action of sulphuric acid.

Preparation of Protocatechutic Acid from Oxybenzoic Acid, and on the Constitution of the first-named Acid.—L. Barth.—The gist of the contents of this paper is the communication of some experiments made by the author to prove that, notwithstanding the observations of Fittig and others, he duly obtained, from oxybenzoic acid, protocatechutic acid, not due to the presence of any para-oxybenzoic acid among the oxybenzoic acid operated upon. When the position (Stellung) of para-oxybenzoic acid is assumed to be 1—4, and that of oxybenzoic acid 1—3, the position of protocatechutic acid should be 1—3—4.

Bimethyl- and Biethyl-Protocatechutic Acid.—R. Koelle.—Bimethyl-protocatechutic acid is prepared by putting into a tube (to be afterwards sealed) 1 grm. of protocatechutic acid, 4 grms. of iodide of methyl, and 1 grm. of pure caustic potassa dissolved in methyl-alcohol (not methylated spirits of wine). This mixture is heated in the sealed tube for some hours to 140°. The contents of the tube are first filtered, the filtrate next evaporated upon the water-bath, and the oily residue boiled for some time with dilute caustic soda solution. The liquid is next treated with dilute sulphuric acid, so as to acidify the fluid, from which then a flocculent substance—viz., the bimethyl-protocatechutic—is separated. This body, having been purified by means of ether, exhibits a crystalline needle-shaped structure; formula—

$$C_6H_3\left\{\begin{matrix}COOH\\O(CH_3)\\O(CH_3)\end{matrix}\right.$$

point of fusion, 170°—171. By distillation with lime, this substance which exhibits the very characteristic reaction with iron in the same manner as protocatechutic, yields an oily fluid boiling between 210° and 220°, and exhibiting a vanilla-like smell; the formula of this oil is—

$$C_6H_4\left\{\begin{matrix}OCH_3\\OCH_3\end{matrix}\right.$$

Biethyl-protocatechutic acid is a solid substance, exhibiting a crystalline needle-shaped form, contains no water of crystallisation, and fuses at 149°; formula—

$$C_6H_3\left\{\begin{matrix}COOH\\OC_2H_5\\OC_2H_5\end{matrix}\right.$$

This acid yields also, when distilled with lime, a fluid similar to that just alluded to, and the potassa, baryta, and silver salts of both the acids hereinbefore mentioned are crystalline substances.

Contribution to the Theory of Dissociation.—A. Horstmann.—An algebraico-physical essay.

Contribution to our knowledge on the Combination Value (Verbindungswerthe) of the Elements.—C. W. Blomstrand.—Notwithstanding the high scientific value of this essay, it is, in consequence of its length and the large number of formulæ required for the proper understanding of this subject, not well suited for abstraction.

Synthesis of Oxaluric Acid.—L. Henry.—The author states that, by causing ethyl-oxy-oxalyl-chloride—

$$C_2O_2\left\{\begin{matrix}Cl\\C_2H_5O\end{matrix}\right.$$

to act upon urea, oxaluric acid is produced according to the following formula:—

$$C_2O_2\left\{\begin{matrix}Cl\\C_2H_5O\end{matrix}\right\}+CO\left\{\begin{matrix}H_2N\\H_2N\end{matrix}\right\}=$$

$$=\left\{\begin{matrix}CO-\cdot-H_2N\\C_2O_2C_2H_5O\end{matrix}\right\}HN+HCl.$$

The result of this reaction is the production of oxalurate of ethyl—

$$\begin{matrix}CO-\cdot-H_2N\\C_2O_2-\cdot-C_2H_5O\end{matrix}\Big\rangle HN,$$

which is soluble in boiling water, separates therefrom on cooling in crystalline state. This substance is difficultly soluble in alcohol, insoluble in ether, barely soluble in cold, but better in boiling water, and very readily dissolved by acids, alkalies, and ammonia. Heated to between 160° and 170°, this body fuses and becomes decomposed, yielding oxamethan, which volatilises and leaves cyanuric acid. Oxalurate of ethyl is decomposed by boiling along with water, oxaluric acid being probably thereby formed, because, when the oxalurate of ethyl is re-crystallised from boiling water, it leaves a mother-liquor which exhibits an acid reaction.

Experiments made with the view to ascertain the Time Required for the Volatilisation and Re-Condensation of Solid Bodies.—A. Naumann.—The bodies experimented with *in vacuo* were sesquichloride of carbon, C_4Cl_6, which fuses under atmospheric pressure at 160°, and boils at 182°; and naphthaline, $C_{10}H_8$, which, under the same condition, fuses at 79·2° and boils at 218°. The main result arrived at is, that the time required for the volatilisation and re-condensation of the substances operated upon is very short, and hardly longer than the time required to obtain the temperature corresponding to a certain pressure indicated by the height of a column of mercury in millimetres.

Specific Volume of Allyl-Alcohol.—H. L. Buff.—The author first discusses the value of some experiments made by Tollens on the specific gravity of allyl-alcohol, and also bearing upon the labours of Kopp respecting the calculation of the specific volume of fluid compounds. The author next refers to the difficulty of obtaining absolutely anhydrous allyl-alcohol, and lastly communicates that the specific volume of an allyl-alcohol boiling between 96·5 and 96·8 is 74·6.

Preliminary Communication on Bioxybenzoic Acid.—M. Ascher.—Although in the heading this paper is alluded to as a preliminary notice only, the subject is treated of at great length and with a large number of quotations of formulæ. It appears that the author has prepared, by a very circuitous and complex plan, a peculiar dioxybenzoic acid, in small quantity only. The barium salt of this acid has the formula $(C_7H_5O_4)_2Ba$. The acid is designated as the 2,4 bioxybenzoic acid, but it is entirely different from protocatechutic acid, which, according to the author, should be styled 1,3,4.

Constitution of Chrysanissic Acid.—H. Salkowski.—The contents of this paper contain the description of the mode of preparation and properties and formulæ of a series of salts of a dinitro-oxybenzoic acid, which is formed by the action of nitrous acid upon chrysanissic acid. Among the bodies spoken of at length are the mono-ethyl-ether, $C_6H_2(NO_2)_2OHCOO(C_2H_5)$, a diethyl-ether which, by the action of ammonia, is converted into chrysanissic acid, which latter, and also the chrysanissic acid ether, are, by boiling with alkalies, converted into dinitro-oxybenzoic acid, which latter is related to the various isomeric oxybenzoic acids in the same manner as picric acid is to phenol.

Contribution to our Knowledge on the Colouring Matter of Cochineal.—C. Liebermann and W. A. van Dorp.

Phenol Pigments.—A. Baeyer.—This essay and the preceding paper are reserved for full translation.

Manufacture of Ethylen Bases on the Large Scale.—Dr. A. W. Hofmann.—The eminent *savant* first calls attention in this paper to the opportunity afforded, by the preparation of chloral on the large scale, as carried on in and near Berlin by several firms of manufacturing chemists, of obtaining, in large quantity, some of the by-products of this operation. The author describes, next, the preparation, on the large scale, of chlorhydrate of ethylen-diamine—

$$C_2H_{10}N_2Cl_2=(C_2H_4)H_4N_2.2HCl,$$

of which salt about 1½ kilos. were obtained in the shape of large-sized needle-shaped crystals 10 to 15 centimetres in length. It is the intention of the author to return to this subject, and publish a full account of his researches on the bodies which are formed by the action of ammonia upon the chlorides and bromides of ethylen.

Preliminary Communication.—O. Wallach.—This paper treats on the action of chloral upon aniline and toluidine; but as yet the author's researches are not complete, and the only reason why this short paper is published is that for some time to come this work cannot be completed.

Observations on the Allyl Group.—A. Oppenheim.—This memoir is divided into the following chapters:—Action of chlorine upon trichlorallyl; iodallyl-mercury and preparation of diallyl.

Researches on the Platinum Bases.—P. T. Cleve.—This very lengthy essay, however valuable in a scientific point of view, is not well suited for any useful abstraction. It contains the following sections:—On a fourth isomer of the formula $PtAk_2Cl_2$; on the nitrites of the two platinum bases, Pta_2; sulphites of the isomeric bases, Pta_2; product of platosemidiamminchlorid with potassa.

Conversion of the Dichlorhydrine boiling at 174° into that boiling at 182°.—H. Hübner and C. Müller.

On α Sulpho-Toluol.—H. Hübner and N. M. Terry.—These papers, although of great scientific value, require, for the proper elucidation of the subject, a series of formulæ too lengthy and complex to admit of being here conveniently reproduced.

Journal für Praktische Chemie, Nos. 8 and 9 (double number), 1871.

This number contains the following original papers and memoirs:—

Continuation of Monograph on the Periodides of the Alkaloids.—Dr. S. M. Jörgensen.—This portion contains the following sections:—Tetra-ethyl-stibonium-triiodide; triethyl-sulfin-superiodide; tetra-ethyl-ammonium-bismuth-iodide; tetra-ethyl-phosphonium-bismuth-iodide; tetra-ethyl-ammonium-bismuth-bromide; tetra-ethyl-phosphonium-bismuth-bromide; tetra-ethyl-arsonium-bismuth-bromide; tetra-ethyl-stibonium-bismuth-bromide; tetra-ethyl-stibonium-bismuth-jodo-bromide; tetra-ethyl-ammonium-bismuth-chloride; tetra-ethyl-phosphonium-bismuth-chloride; tetra-ethyl-phosphonium-bismuth-iodo-chloride; tetra-ethyl-arsonium-bismuth-chloride; tetra-ethyl-stibonium-bismuth-chloride; tetra-ethyl-stibonium-bismuth-iodo-chloride.

Simple Apparatus to Serve for Washing, as well as simultaneously Absorbing Gas.—Dr. H. Fleck.—Illustrated with a woodcut essentially required for properly understanding the arrangement and mode of working with this contrivance.

Application of a Reflector to Spectrum Analysis.—Dr. H. Fleck.—Illustrated with a woodcut.

Action of Hydrobromic Acid upon Citric Acid.—M. Mercadante.—The author expected to obtain, by causing hydrobromic acid to act upon citric acid, first a bromated acid, $C_6H_7BrO_6$, and from that, by the aid of nascent hydrogen, tricarballylic acid, $C_6H_8O_6$; but, instead of obtaining this result, aconitic acid was formed, which has also been observed to result from the action of hydrochloric acid upon citric acid by Dessaigne. This reaction is due to the elimination of a molecule of water from citric acid, and is elucidated by the following formulæ:—

$$\underbrace{\left.\begin{array}{l}CH_2.COOH\\|\\HO.C.COOH\\|\\CH_2.COOH\end{array}\right\}}_{\text{Citric acid.}} + HBr = \underbrace{\left\{\begin{array}{l}CH_2.COOH\\|\\Br.C.COOH\\|\\CH_2.COOH\end{array}\right\}}_{\text{Brom-tricarballylic acid.}} + H_2O.$$

$$\left.\begin{array}{l}CH_2.COOH\\|\\Br.C.COOH\\|\\CH_2.COOH\end{array}\right\} = \underbrace{\left\{\begin{array}{l}CH.COOH\\||\\C.COOH\\|\\CH_2.COOH\end{array}\right.}_{\text{Aconitic acid.}}$$

Normal Valerianic Acid.—A. Lieben and A. Rossi.—This lengthy essay describes the mode of preparation of the acid alluded to from butyl-cyanide, by boiling it with alcoholic potassa solution. The acid in pure state is a fluid; sp. gr. at 0°=0·9577, and at 99·3°=0·9034; boils at 185°; formula, $C_5H_{10}O_2$. The authors describe a series of the salts of this acid, observing that they confirmed, by their researches, the older experiments of Dumas and Stas, anent the acid obtained from the amyl-alcohol of fermentation, that it yields with baryta a syrup-like fluid salt (see *Ann. Chim. Phys.* [2], vol. lxxiii., p. 134).

Continuation of the Researches on the Compounds of Ilmenium and Niobium, and on the Composition of the Niobium Minerals.—R. Hermann.—This exhaustive monograph, to be further continued, is, in spite of its intrinsic scientific value, far too lengthy for any further quotation.

Conversion of Succinic Acid in the corresponding Diatomic Alcohol.—Dr. A. Saytzeff.—This preliminary notice states that the author obtained, by the action of sodium amalgam upon a mixture of chloride, succinyl, and acetic acid in ethereal solution, butyl-glycol, while the thereby simultaneously-produced glycol is probably the homologon to ethyl-glycol. The full record of these experiments will shortly be made public.

Cobalt Ultramarine, a Contribution to our Knowledge on the Origin of the Colour of Substances.—W. Stein.—The author first refers briefly to his researches on ultramarine (see CHEMICAL NEWS, vol. xxiii., pp. 119, 142, and 204), reminding his readers that a blue colour may result from the intimate mixing of a black and white molecule. Next, this paper contains researches on a sample of cobalt ultramarine, which had been kept for some twenty years in the Museum of the Dresden Polytechnic School. The result of the analysis of that substance led to the following composition, in 100 parts:—Silica, 4·0; alumina, 68·45; cobalt (metal), 20·80; oxygen, 6·75. The composition of the oxide of cobalt present in this ultramarine is $4CoO.Co_2O_3$. The analysis was confirmed by the synthesis of an ultramarine cobalt—viz., by simply igniting the black oxide of cobalt of commerce with alumina.

Ethyl-Diacetic Acid and some of its Derivatives.—A. Geuther.—The first half-page of this paper being only here published, it is reserved for further notice when complete.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, May and June (double number), 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences;—

Cotton Seeds.—Dr. F. Fluckiger.—This lengthy essay contains, in the first place, a succinctly written botanical description of the several kinds of shrubs and trees from which cotton is obtained; next, we meet here with a histological and morphological minute description of the microscopical structure of the cotton seeds, illustrated by coloured lithographs. The latter portion of this essay is devoted to a well-condensed and very complete review of all that has been done in various parts of the world in reference to the scientific, as well as industrial, researches on cotton seeds and the oil it yields. According to the author, the quantity of cotton seed annually gathered amounts to 1,000,000,000 of kilos., which, under the least favourable conditions, would yield 150,000,000 kilos. of oil.

Method of Air Analysis applied to Phuto-Physiological Research.—H. Karsten.—The contents of this paper cannot be rendered intelligible without the reproduction of the woodcuts elucidating the ingenious and complex apparatus here described.

Qualitative and Quantitative Comparison of the Mineral Constituents of a Plant, and of the Constituents of the Soil it has been Cultivated in.—H. Reinsch.—Notwithstanding its intrinsic merits, this lengthy memoir is not well suited for useful abstraction. The author brings forward in this essay, and proves, by experiments made on an extensive scale, some new views concerning the growth and nutrition of plants and their relation to the soil, as well as to the atmosphere.

Poisoning of Bees by means of Yeast.—Dr. R. Mirus.—The main point of interest in this paper is, that a mixture of honey and beer-yeast acts as a poison to bees, in consequence of inducing, when partaken of by these insects, fermentation in the stomach of these animals; the beer-yeast also acts upon bees as a drastic purgative. Neither by microscopical, nor by chemical research, was any other poisonous or deleterious substance found, either in the bodies of the insects or in the mixture above alluded to.

Impurities present in the Reduced Iron, Ferrum Hydrogenio Reductum.—E. Schering.—While this substance has hitherto not been obtained quite free from a more or less large quantity of sulphuret of iron, the author calls attention to the fact—an important one, indeed—that he has met with samples of this medicament which, in addition to the impurity spoken of, also contains oxides and carburets of iron, and even cyanide of potassium, due in all likelihood to the reprehensible practice of preparing the reduced iron from the residues of the preparation of cyanide of potassium from the ferrocyanide of potassium. It is therefore advisable for pharmaceutists to test the ferrum hydrogenio reductum they purchase for the presence of the cyanide alluded to.

La Revue des Scientifique de la France et de l'Etranger, July 8, 1871.

This number does not contain any original papers or memoirs relating to chemistry or allied sciences, but there is an interesting paper on the—

University of Strasburg.—E. Alglave.—Strasburg was once a free city—that is to say, a free and independent republic, just as Hamburg and Bremen are now, and as, during the middle ages, many towns and cities were on the Continent of Europe. As such, Strasburg had a University, which remained in existence until the first Napoleon created what is termed L'Université de France. By the arrangements under which that establishment exists, there was founded at Strasburg a faculty of medicine, of literature, and of sciences, and a school of

pharmacy, and also a faculty of Protestant (Lutheran) theology. This establishment was exceedingly well arranged, and possessed fine collections, libraries, and museums. The Prussian Government intend to establish a very complete university at Strasburg, and, while they have acquired the cession of all the rich *matériel* already in that city, intend to endow Strasburg University with £32,000 a year. The French Government is arranging to re-establish at Nancy (now a frontier town) the University of which Strasburg was the see, while Lyons also is mentioned for a similar purpose. It is a happy feature to learn from this and other scientific periodicals that the French nation is becoming alive to the high importance of general sound education, and of largely-extended scientific instruction.

Revue Universelle des Mines, de la Métallurgie, des Travaux Publics des Sciences et des Arts Appliqués à l'Industrie (double number), for the first four months of 1871.

This number contains the following original papers and essays relating to chemistry and collateral sciences:—

Mercury Mines of Almaden, Spain.—José de Monastério y Corréa.—This esssy, illustrated with a series of engravings, has been written by the author, Inspector General of Mines to the Spanish Government, while sojourning lately at Liège, Belgium, at the request of the editor of this periodical. This valuable memoir, too lengthy for any useful abstraction, contains the following sections:—History of the Almaden mines; situation; geology; veins and seams of ore; mode of working the mines, and extraction of the ore; pumping engines and other machinery required for keeping the workings free from water; ventilation; shifts of workmen; hygienic condition of the workmen.

Note on the Discovery of Four New Seams of Coal at the Collieries of the Grand-Hornu (near Mons, Belgium).—H. Glépin.—Illustrated with maps and engravings.

Influence which the Cession of Alsace and Lorraine to Germany will have on Metallurgical Industry.—Ch. de Cuyper.—From this paper it would seem that, not only in a strategic, but also in an industrial and metallurgical way, Germany has got the mastery to such an extent, that even the United Kingdom will be, at no distant day, very seriously affected by recent events in its metallurgical industry and commercial interests.

Les Mondes, July 13, 1871.

This number contains the following original matter relating to chemistry and collateral sciences:—

Record of the Observations on Meteorites seen in Italy during the Months of March and April of the Current Year.—Rev. Father Denza, S.J.—An important contribution to our knowledge of the phenomena vulgarly known as falling stars, minutely described as observed by Italian astronomers.

Brief Biography of the late Ramon de la Sagra.—Dr. Sacc.—To most of our readers the name of Ramon de la Sagra will be familiar, in more than one sense. The illustrious *savant* was born at Corunna in 1811, and studied, first, medicine, at Bilbao, afterwards exact sciences, at Madrid. He embarked, while yet a young man, in an industrial enterprise, which unfortunately proved a failure, and in consequence of which he left Spain for Cuba, where, for a period of seventeen years, he was director of the botanic gardens near Havana; while engaged in this capacity, the deceased edited his magnificent "Fauna of Cuba" (12 folio volumes, published by J. B. Ballière, Paris). Later in life, De la Sagra returned to Spain; but it appears that, from some cause or other, he has been compelled to leave that country; and he died on the 25th of May last, at Cortaillad, in Switzerland. The deceased was well known, also, for the great interest he took in the improvement of the general education of his countrymen. In politics he was an ardent but moderate liberal.

New Spectroscopic Process.—Rev. A. Secchi, S.J.—The eminent *savant* describes, in this lengthy paper, an optical apparatus, by the aid of which he has been enabled to see, in the field of the spectroscope, the spectrum of the protuberances and the disc of the sun, so that he could readily distinguish the spots and other particulars as easily as if seen with coloured glasses.

Description of a Self-Acting Gas Apparatus not requiring a Gasholder and not Liable to Explosion.—MM. Moussard and Kreiger.—This description is accompanied by a woodcut essentially required for the proper understanding of the working of this apparatus, which is obtainable from F. Rouillé, 8, Boulevard Bonne-Nouvelle, Paris, at a comparatively low price; while, according to the testimony of the Abbé Moigno, who has witnessed the experiments, the light of the gas produced (really a mixture of air with vapours of very volatile hydrocarbons) is very rich and pure, and cheap—exclusive of the duty now imposed in France on the liquids just alluded to—only 15 centimes (about 1½d. per cubic metre) = 35·316 English cubic feet.

NOTES AND QUERIES.

Cement to Resist Nitric Acid.—(Reply to T. Kenyon.)—You are referred to Chemical News, vol. xix., p. 287; vol. xx., p. 23; and vol. xxii., p. 48.

Distillation of Wood.—Will you kindly tell me whether there is a work on the manufactures arising from the destructive distillation of wood, and where it is to be obtained?—J. H. Mayor.

Carbolic Acid.—Will your correspondent, Dr. Ballard, who inserted some time ago a communication in your journal on the above subject, inform me where it can be obtained (for disinfection), without the unpleasant odour usually attaching to it.—Carbolic.

Anthracene.—(Reply to Henry Dorsett.)—In addition to what is published (see Chemical News, vol. xxiii., pp. 143 and 156), you will find a very good account of the best and most practical methods of preparing anthracene in Dr. Elsner's "Chemisch-Technischen Mittheilungen" for 1869-70, pp. 13 and 14; but this paper is too lengthy for quotation here, and does not admit of being condensed. You may inspect this book at the Library of the Commissioners of Patents.

Skein Silk.—We English dyers have to contend very much against foreign dyed silk weighted with gambia to 323 to the pound. The gambia is forced on the silk with crystals of muriate of tin. Now comes our difficulty: after getting on the weight, how to kill the tin, so as to follow with the logwood to make a black,—we resort to boiling-hot soap-lather; the danger is in making the silk tender. Can you or any of your readers give me a more rapid and safer mode of killing the tin, without danger to the silk; you must understand it is in the skein, not manufactured.—C. R. Stevens.

[We think that experimenting is the only means of determining the best mode of killing the tin. The dyeing of silk, especially black, is a delicate matter, and the fibre itself is not such as will stand much *chemicking*, as it is termed.—Ed. *C. N.*]

TO CORRESPONDENTS.

G. F. Ansell.—Received with thanks.

C. E. Craven.—(1). Messrs. Trübner and Co. have just published "A Practical Treatise on the Manufacture of Soaps," by Campbell Morfit, M.D., &c.; it will shortly be reviewed in our pages. (2). The work is in the press.

C. J. Watson.—This correspondent informs us, respecting an extract on "The Phenomena of Vibration" from the *Scientific American* in our issue of July 21st, that the flame examined was a singing flame which required a tube to cause it to sing. The paragraph mentioned the flame of a gas light, in a glass tube to prevent disturbance by air currents.

A Subscriber.—To become a Fellow of the Chemical Society it is necessary that your application be signed by three Fellows who know you personally, and also by two Fellows on general knowledge; fellows are elected by ballot. The Secretary, Burlington House, will supply you with the necessary forms of application, &c.

J. M. Merrick.—We shall be glad to receive the articles.

S. A. Sadler.—Consult the *Transactions of the Royal Agricultural Society*, or article on "Artificial Manures" in Ure's "Dictionary of Arts and Sciences."

A. F. Hargreaves.—We do not know; an advertisement would probably lead to your obtaining the information.

J. Draper.—Address to Messrs. Von Baerl and Co., Worms, Hesse Darmstadt, Germany.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 612.

THE DICHROISM OF THE VAPOUR OF IODINE.*

By Dr. ANDREWS, F.R.S.

THE fine purple colour of the vapour of iodine arises from its transmitting freely the red and blue rays of the spectrum, while it absorbs nearly the whole of the green rays. The transmitted light passes freely through a red copper or a blue cobalt glass. But if the iodine vapour be sufficiently dense, the whole of the red rays are absorbed, and the transmitted rays are of a pure blue colour. They are now freely transmitted as before by the cobalt glass, but will not pass through the red glass. A solution of iodine in sulphide of carbon exhibits a similar dichroism, and according to its density appears either purple or blue when white light is transmitted through it. The alcoholic solution, on the contrary, is of a red colour, and does not exhibit any dichroism.

THE ACTION OF HEAT ON BROMINE.*

By Dr. ANDREWS, F.R.S.

IF a fine tube is filled one-half with liquid bromine and one-half with the vapour of bromine, and after being hermetically sealed is gradually heated till the temperature is above the critical point, the whole of the bromine becomes quite opaque, and the tube has the aspect of being filled with a dark red and opaque resin. A measure of the change of power of transmitting light in this case may be obtained by varying the proportion of liquid and vapour in the tube. Even liquid bromine transmits much less light when heated strongly in an hermetically-sealed tube than its ordinary state.

ON SORBIT.†

By PROFESSOR DELFFS.

TWENTY years ago M. Pelouze (*Ann. de Chim. et de Phys.* 3 ser., vol. xxxv., p. 222) discovered a crystalline substance in the fruits of *Sorbus aucuparia*, which he called *sorbin*. Since that time very few chemists have paid attention to this matter, and, as far as I know, nobody in my country succeeded in preparing it again. The principal of one of our greatest manufactories of chemical preparations, to whom I addressed myself, told me that he never found the least trace of the said substance, although he had worked up large quantities of the above-mentioned fruits for preparing malic acid. and to the same result came M. Byschl (*Buchner's N. Repert. der Pharm.*, vol. iii., p. 4), who asserts that there is no ready formed sorbin in the ripe berries of *Sorbus aucuparia*. In my two first attempts of getting sorbin I failed also, but in the last year I succeeded, and at the same time I became aware of the reason of my first failures. When I first tried to get sorbin, I thought it profitable to combine the preparation of malic acid with the prescription given by M. Pelouze for getting sorbin, and, therefore, I separated the former by means of acetate of lead, before I followed the same way as M. Pelouze. This is the reason, I think, which has prevented the success of myself as well as of other chemists, in the preparation of sorbin.

As I will not trouble you by repeating a method to be found in all manuals of chemistry, it is sufficient to say, that when I kept strictly to the prescription of M. Pelouze, I got a large quantity of beautiful crystals, a specimen of which is contained in this tube. After I had got these I tried to obtain the malic acid from the residue, but I found that the malic acid had quite disappeared. To this, I must add, that the alcoholic fermentation, which takes place after the juice of the berries of *Sorbus aucuparia* has been left a few days in a tepid place, is easier perceived by the formation of carbonic acid than by the smell of spirit of wine. I think it, therefore, not improbable, that there is a connection between the disappearance of the malic acid and the small produce of spirit of wine on the one side, and the formation of sorbin on the other. Suppose the malic acid—commonly called *bibasic*, and, therefore, apt to form a bimalate of ethyl ($=C_4H_5O+2C_4H_2O_4+HO$)—assimilates two equivalents of water to this compound, you will have then the equation $C_4H_5O+2C_4H_2O_4+3HO=C_{12}H_{12}O_{12}$, the latter formula of which gives the composition of sorbin.

As what belongs to the preparation of sorbin I have only to add, that the dark sticky lye in which the crystals are formed, can very easily be separated by putting both on a brick. After a few days' repose, the brick has absorbed nearly all the lye, and the pale yellow coloured crystals of sorbin, if dissolved in water and left to spontaneous evaporation, become very soon colourless.

The sorbin belongs to the same group as the mannit, quercit, inosit, dulcit, pinit, &c., and, as the last syllable is always characteristic in organic chemistry, its name I think, should be changed into sorbit.

Further experiments are required to prove, if the supposed genesis of sorbin is true or not, but, in any case, I am convinced, that there is no sorbin *ready formed* in the fruits of *Sorbus aucuparia*.

IMPROVEMENTS IN CHLORIMETRY.

By JOHN SMYTH, jun., A.M., M.I.C.E.I., F.M.S.

THE author showed that the use of the milky solution of bleaching powder in chlorimetry is unsatisfactory, and hence was glad to discover a method of securing a clear solution containing all the chlorine. by dissolving it in an alkaline solution. This is conveniently done by adding say 10 grms. of bleaching powder to 20 grms. of soda crystals ($NaOC_2+10HO$), filtering out the precipitated carbonate of lime, which is known to be washed when it no longer discharges the colour of dilute sulphate of indigo, and making up the filtrate by water to 1 litre of fluid. It is a clear, colourless liquid, of the sp. gr. of 1·007; but, if made of sp. gr. 1·233, slightly greenish, having a pleasant oily feeling between the fingers, contrasting favourably with the roughness of the decanted solution of the bleaching powder, with which it gives a precipitate. Most satisfactory results are obtained from it by all the chlorimetrical methods, and it has the additional advantage of showing the amount of lime in the sample, by adding a solution of known strength of carbonate of soda until a precipitate is no longer formed. It is manufactured and used in the north of Ireland for bleaching fine linens; and from the ease and accuracy with which its percentage of chlorine was obtained, the author was led to investigate the feasibility of converting bleaching powder into it for chlorimetrical purposes, and obtained the above results.

* Abstract of a Paper read before the British Association, Edinburgh Meeting, Section B.

† Read before the British Association, Edinburgh Meeting, Section B.

* Abstract of a Paper read before the British Association, Edinburgh Meeting, Section B.

ON THE

CORROSION OF COPPER PLATES BY NITRATE OF SILVER.*

By J. H. GLADSTONE, F.R.S., and ALFRED TRIBE, F.C.S.

In some recent experiments in chemical dynamics, the authors had occasion to study the action of nitrate of silver on copper plates in various positions. They observed that, when the plate was vertical, there was rather more corrosion at the bottom than at the top. This is easily accounted for by the upward current, which flows along the surface of the deposited crystals, and which necessitates a movement of the nitrate of silver solution towards the copper plate, especially impinging on the lower part. It was also found that, when the copper plate was varnished on one side, it produced rather more than half the previous decomposition, and was most corroded at the edges of the varnish. By making patterns with the varnish, this edge action became very evident. This was explained by the fact that the long crystals of silver growing out from the copper at the borders can spread their branches into the open space at the side, and so draw their supply from a larger mass of solution than the crystals in the middle can do; and increased crystallisation of silver means increased solution of copper. This was proved by making the varnish a perpendicular wall instead of a thin layer, when the greater corrosion was not obtained. In a plate completely surrounded with liquid, the greatest growth of crystals is also evidently from the angles. It was likewise observed that, if a vertical plate be immersed, the lower part in nitrate of copper, and the upper part in nitrate of silver, there is greater corrosion about the point of junction; this was attributed to the greater conduction of the stronger liquid.

THE ESTIMATION OF SULPHUR IN COAL AND COKE.*

By F. CRACE CALVERT, F.R.S.

HAVING for many years observed the analyses of the amounts of sulphur existing in coals and coke as published in various works, I have come to the conclusion that the difference observed in the amounts of sulphur found in the same coal by different chemists is not due so much to a difference in accuracy or wide differences of samples as to the various methods adopted to determine the weight of the sulphur. Without entering into the merits of the various processes which have been proposed to effect this object, I only wish in this paper to point out sources of error attending the method which, I believe, to be most usually adopted, which consists in adding to an oxidising *aqua regia* a known weight of very finely powdered coal or coke, leaving it to be digested at a moderate temperature until the whole of the sulphur is supposed to be converted into sulphuric acid, then driving away the great excess of acid, boiling with water, filtering, washing the carbonaceous residue on the filter, and determining the amount of sulphuric acid in the filtrate.

In operating in this manner, there are three serious sources of error. The first is that the sulphate of lime, which many coals contain in considerable proportion, may mislead the analyst, owing to its solubility in water being much increased by the presence of free acid. The figures usually obtained include the sulphur combined with the calcium as well as that existing as pyrites in coal, or sulphuret of iron in coke. It is, however, most important, in a metallurgical point of view, to give the figures separately, for the sulphur combined with the calcium as sulphate of lime will not leave its strong base to deteriorate the quality of the iron, either in the blast furnace or in any of the subsequent processes of manufacture, whilst the pyrites, although losing part of its sulphur as sulphurous acid, mixes as monosulphuret with the iron, and seriously lowers its commercial value.

It appeared to me, therefore, important to devise a method by which the amounts of sulphur, combined with calcium and iron, respectively, could be determined, and the following process I found to be successful. The finely pulverised coal or coke is boiled for about twenty hours with water containing an equal weight of coal or coke taken. By this means the sulphate of lime or sulphuret of calcium is decomposed, whilst the sulphuret of iron remains unattacked. The residue is then filtered and rapidly washed with boiling water. If a coke has been taken, nitric acid in slight excess must be added to the filtrate to convert the sulphuret of sodium into sulphate, and the sulphuric acid determined in the usual manner. The sulphur found in the residue will then represent the amount present in the coal or coke as pyrites or sulphuret of iron.

The value of a coal or coke for use in the iron manufacture may easily be seriously miscalculated if this difference be not taken into consideration, as may be seen from the subjoined table, which gives the figures found in six samples sent to my laboratory for analysis. It will be seen that by the usual process the coals would be condemned as unfit for use in the manufacture of iron, while, in fact, they are well adapted for that purpose.

	Old process.		New process.		In washings.		Difference between processes.
	Sulphur, per cent.	Mean.	Sulphur, per cent.	Mean.	Sulphur, per cent.	Mean.	
1.	1·36 1·40	1·38	0·60 0·58	0·59	0·79 0·78	0·79	0·79
2.	1·59 1·55	1·57	0·63 0·67	0·65	0·97 0·95	0·96	0·92
3.	1·78 1·73	1·75	0·89 0·85	0·87	0·85 0·88	0·87	0·88
4.	1·37 1·38	1·38	0·50 0·53	0·52	0·98 1·00	0·99	0·86
5.	1·41 1·42	1·42	0·54 0·56	0·55	0·91 0·94	0·93	0·87
6.	1·58 1·60	1·59	0·68 0·70	0·69	0·97 0·99	0·98	0·90

The second objection to the method of analysis above given is that if the evaporation of the aqua regia be carried too far a subsulphate of iron is sometimes formed, which no amount of boiling with water will remove from the carbonaceous mass, and the chemist may thus obtain too small a quantity of sulphur in the coal or coke under examination.

The third objection is that in an acid liquor, especially if any nitric acid be present, the amount of sulphur found will always be much below the actual quantity present, owing to the fact that the formation of sulphate of baryta is, in some measure, prevented by the presence of the acid, the proportion, of course, varying with the concentration of the acid. Thus I showed some years since that the non-formation of sulphate of baryta could reach the large proportion of 14 grs. of sulphate of baryta in 1000 grs. of nitric acid, of sp. gr. 1·21, an amount greatly exceeding that produced from the sulphur usually found in 100 grs. of coal or coke.*

As the amount of nitric acid left in the liquor is unknown, the extent to which the formation of sulphate of baryta has been prevented is also unknown, and, consequently, the figures obtained cannot be relied upon.

I cannot impress too much upon young analysts the importance of paying attention to the fact that the formation

* Abstract of a Paper read before the British Association, Edinburgh Meeting, Section A.

* Read before the British Association, Edinburgh Meeting, Section B.

* "On the Solubility of Sulphate of Baryta in Acid Solutions," *Memoirs of the Manchester Literary and Philosophical Society*, vol. xiv. 1856.

of sulphate of baryta is prevented by, and is in ratio to, the excess of nitric acid existing in the fluid, and the common belief, that leaving the liquor to stand twenty-four hours, overcomes the objection, is only approximately true, as only a part of the sulphuric acid is precipitated, while part remains in solution.

To avoid these two latter objections, I always, after concentrating the acid liquor, add carbonate of soda in excess and heat to near the fusing-point. By this means the iron, silica, and alumina, are rendered insoluble; the mass is then treated with water, washed well, and the filtrate made slightly acid with acetic acid. The sulphate of baryta is thrown down from this liquor immediately and completely.

If the dry oxidising process is followed, that is, the addition of the finely pulverised coal or coke to a fused mixture of carbonate of potash and of chlorate or nitrate of potash, then two of the above objections are removed, viz., the non-formation of sulphate of baryta in an acid liquid or the production of a basic sulphate of sesquioxide of iron, but there still remains the objection of the determination of the sulphuric acid of the sulphate of lime, together with that of the pyrites; and, further, I have never obtained a satisfactory determination of sulphur in an organic product or in coal when I have employed this method. There has always been a loss of sulphur.

PRELIMINARY NOTE ON OXY-CANNABIN.

By T. BOLAS and E. E. H. FRANCIS.

WE have ascertained that oxy-cannabin contains nitrogen, which was overlooked in our original examination (*Journ. Chem. Soc.*, xxii., 417). Subjoined are the analytical results obtained with a carefully purified specimen.

III. 0·4663 grm. sub. gave 1·0184 grms. CO_2 and 0·2100 H_2O.
IV. 0·3951 grm. sub. gave 0·8711 grm. CO_2 and 0·1851 H_2O.
V. 0·2007 grm. sub. gave 10·81 c.c. N (cor.).
VI. 0·2188 grms. sub. gave 11·63 c.c. N (cor.).

	Theory.		Found.				
			III.	IV.	V.	VI.	Mean.
C_{20} ..	240	60	59·56	60·13	—	—	59·85
H_{20} ..	20	5	5·00	5·21	—	—	5·10
N_2 ..	28	7	—	—	6·76	6·67	6·72
O_7 ..	112	28	—	—	—	—	—
	100						

This substance is still under investigation.

OBSERVATIONS ON THE COLOUR OF FLUORESCENT SOLUTIONS.

By HENRY MORTON, Ph.D.,
President of the Stevens Institute of Technology.

As the result of a series of experiments to be presently described, I have come to the curious conclusion that all the familiar fluorescent solutions, such as the tincture of turmeric, of agaric, of chlorophyl, and the solution of nitrate of uranium, emit light of the same colour by fluorescence—viz., blue, identical with that developed by acid salts of quinine. This blue, however, in all cases, that of quinine included, being, not of a single tint or refrangibility, but yielding a continuous spectrum in which the more refrangible rays predominate.

My attention was first drawn to the subject by observing that a specimen of mixed asphalt, which is here largely used in the preparation of pavements, yielded a light yellow solution with alcohol which fluoresced blue, and an orange solution with turpentine which fluoresced green. It at once occurred to me that the green colour was simply due to the absorptive action of the coloured solution, and not to the development of green rays.

Examined with the spectroscope, the seemingly green fluorescence showed no increase in the green or yellow part of the spectrum, as compared with the blue fluorescence, but only an absorption of the red and violet ends.

When, however, a piece of fluorescing canary-glass or solid nitrate of uranium was examined, the green light was, as is well known, of course, largely augmented.

I also found that when, by filtration through animal charcoal, the solution in turpentine was reduced in colour, the green tint of the fluorescence disappeared in a corresponding degree.

This alone would, however, have proved nothing, as a green-fluorescing matter might have been absorbed by the charcoal, but in connection with the spectroscopic result it was of interest.

I next took up for examination the tincture of turmeric. This is set down in standard works, such as those of Du Moncel, as fluorescing red.

This solution, when concentrated, has a rich orange-red colour, and the jacket of a Geissler tube being filled with it all the light reaching the eye from the electric discharge within is of a deep orange or red colour. If, however, the solution is simply diluted until its colour is reduced to a rich yellow, the fluorescence appears green. The same result follows from filtration through bone-black, with a marked increase in the amount of fluorescence visible as compared with the red solution.

By continuing the decolouration until the liquid is of a very light tint, its fluorescence is distinctly blue.

The results with the spectroscope, when it was applied in this case, were the same as with the solution of asphalt. Such, also, is the case with tinctures of chlorophyl, which, when fresh and green gives a green light, and when old and brown a grey colour.

Finally, I took up the nitrate of uranium, about which such contradictory statements have been published. This salt, in its solid state, gives a brilliant green fluorescence, whose spectrum is figured by Becquerel, and abounds in green rays; but in solution it gives a very feeble fluorescence, far inferior to that of turmeric, and of no more green tint than would be due to its yellow colour.

So, in fact, says also the spectroscope.

From these results, it would seem that the molecules of fluorescent bodies in solution are not capable of restricting their vibrations to limited rates, but move at rates corresponding with all refrangibilities, having simply an excess of the higher ones; though the same substances in the solid state may act quite differently, as in the case of nitrate of uranium, and possibly the fluorescent material in the asphalt, which may be related to the solid hydrocarbon fluorescing green which Becquerel mentions.—"La Lumiere," vol. i., p. 382.

In this general connection, let me mention that I have observed that, while the acid salts of quinia generally are fluorescent, the chloride is not, and that hydrochloric acid will decompose the acid sulphate, so as to destroy its fluorescence. There are several other points in connection with this and the foregoing subject which I must leave for a subsequent discussion.

ON THE USE OF POROUS CONES IN FILTRATION.

By CHARLES E. MUNROE.

THE sulphides of arsenic and antimony being quite easily obtained have long been regarded as furnishing the readiest and best means for the estimation of these two elements. A serious objection has, however, arisen in the fact that they must be determined upon weighed

filters, and that paper filters cannot be dried above 100° without danger of loss. Hence, a filter which could be weighed easily and withstand a high temperature became a desideratum.

Taylor* accomplished this with sand filters, and obtained some excellent results. This method, however, requires experienced and careful manipulation, reasons which will probably prevent its being generally used.

Under these circumstances the idea of using a cone made of very porous earthenware, and as a substitute for the paper filter, presented itself to me, and has been carried out in the following manner:—

The cones† are made of very light, porous earthenware, and have an angle of about 60°. They are used in the following way:—

A section of a seamless rubber tube, *a*, is stretched around the mouth of a funnel, *b*, preferably a Bunsen funnel, allowing a portion of the tube to project above the top. This part will immediately arrange itself at right angles to the top of the funnel; into the circle thus formed the

cone, *c*, is put. It is then connected with the Bunsen pump. When the cone is moistened and the pressure applied, the rubber band forms an air-tight joint, and the liquid runs through with great rapidity. Before the cones are applied to quantitative work they must be carefully washed, first with concentrated chlorhydric acid, then with distilled water, dried, and weighed. A small porcelain crucible was always kept at the balance in which to weigh them. With this apparatus the following results have been obtained.

A sample of ordinary crystallised potassio-antimonylic tartrate gave—

Grms.	Grms.	
(1). 1·1069	gave 0·5570	Sb_2S_3 = 35·94 per cent Sb.
(2). 1·6985	,, 0·8550	,, = 35·96 ,, ,,

Mean 35·95.‡

A specimen of the same salt, carefully re-crystallised, gave upon analysis the following data.

Grms.	Grms.	
(1). 0·7755	gave 0·3955	Sb_2S_3 = 36·40 per cent Sb.
(2). 0·6050	,, 0·3085	,, = 36·42 ,, ,,

Mean 36·41.

Mr. W. Lincoln also made an analysis of the same salt by means of the cones, and kindly permits me to use his results.

Grms.	Grms.	
(1). 0·4683	gave 0·2388	Sb_2S_3 = 36·41 per cent Sb.
(2). 0·8135	,, 0·4144	,, = 36·38 ,, ,,

Mean 36·40.

In all of these analyses Sb = 120.

The Sb_2S_3 was precipitated in the manner recommended by Sharples.* It is necessary that the boiling should proceed for some time, a brisk current of sulphydric acid being passed through the liquid. The precipitate is then filtered upon the weighed cone, and the whole dried in an air-bath at 300°. The antimonous sulphide is at this temperature converted into the gray crystalline modification.

No formula has yet been found which agrees with either of the percentages obtained. As the atomic weight of antimony is differently stated from 120 to 122, this is easily explained.

It is unfortunate that the atomic weight of antimony is yet so uncertain, but it is hoped that these results, agreeing so closely among themselves, will be accepted as proving the value of the process.

Arsenious Oxide.—This was the next substance analysed. The sulphide was precipitated in the usual manner, but it was noticed that by having the solution decidedly acid and passing through it a very rapid stream of sulphydric acid, that the sulphide was obtained in a more granular condition.

The precipitate can be dried with impunity at 120°. At 140° the lemon-yellow sulphide commences to change to red, and at 180° is completely converted into the liver-red variety.

With ordinary commercial arsenious oxide, the following results were obtained.

Grms.	Grms.		Found per cents.	Theory per cents.	
(1). 1·7940	gave 2·2260	As_2S_3 =	75·64	75·76	As.
(2). 0·5770	,, 0·7165	,, =	75·84	,,	,,
(3). 0·8520	,, 1·0579	,, =	75·68	,,	,,

Mean 75·72

Mr. Lincoln obtained as the result of two analyses:—

Grms.	Grms.		Found per cents.	Theory per cents.	
(1). 0·8926	gave 1·1087	As_2S_3 =	75·76	75·76	As.
(2). 0·8145	,, 1·0128	,, =	75·77	,,	,,

Mean 75·76

These results show that this process renders the estimation of antimony and arsenic one of the simplest and most accurate operations in quantitative analysis.

The cones can be used repeatedly and can replace paper filters in every case. They will, undoubtedly, be found to be of great value in commercial work, for drying crystals and filtering corrosive liquids. As they will stand sudden changes of temperature without breaking, they can be substituted to advantage in many cases for crucibles.

In closing, I desire to return my sincere thanks to my kind teacher, Dr. Gibbs, who has furnished me with the material for these investigations, and has aided me by his counsels and advice.—*American Journal of Science.*

ON THE ORIGIN OF THE DIAMOND.†

By the Rev. W. B. CLARKE, M.A., F.G.S.

(Concluded from p. 66).

Diamonds in Russia.

RUSSIA is a country in which diamonds are also found, but sparingly, as near Bissersk and Chrestovodsvingensk in the Ural chain; the detritus in which they occur being made up of angular fragments of chloritic, talcose, and

* *American Journal of Science*, II., vol. xliv., p. 215.

† Much credit is due to the firm of A. W. and H. C. Robertson, of Chelsea, Mass., who, by their superior mechanical skill, have aided me much in accomplishing the desired result.

‡ Taylor obtained as the mean of three analyses 36·08.

* *American Journal of Science*, II., vol. i., p. 248.

† From the Anniversary Address delivered to the Royal Society of New South Wales.

quartzose rocks. The former of these places was mentioned in 1831 in the "*Gornoï*" *Journal of Petersburg*; and in 1839 Baron von Meyendorf stated to the Geological Society of France that diamonds had been discovered in two different localities, and that they had been found in a microscopic form in native iridium which had been brought to Paris. (*Bull.*, ii., 314).

The first Ural diamond was found at Bissersk in 1829 after Humboldt's visit to Count Polier; three others were found afterwards in that year. In 1830 other three were found. M. Karpoff, a mining officer, shortly after was deputed to carry on the search, and four were discovered, which are described as colourless, diaphonous, smooth, and very bright, with 42 triangular facets. One was broken in two.

Thirty-seven others were taken, the last in July, 1833, from the Adolphskoi Mine, and were used by the Countess Polier in decoration of her church images. One weighed ⅛ of a carat. Their forms showed from twelve to forty-two curved facets, smooth and sparkling. In 1831, however, a few were found in the gold land of M. Medjer near Ekatherinburg. One was given to the Institute of Mines by his son after the father's death. It was a rhomboidal dodecahedron with rounded edges and translucent, weighing ⅛ of a carat. (*Bull. Geol. Soc. de France*, vol. iv., p. 100, 1833). The information here given was received from Count de Cancrine, Russian Minister of Finance.

Sir Roderick Murchison, in 1841, saw forty diamonds from the Adolphskoi rivulet; but as the gold found with them did not pay, no further search was made for diamonds. Three other localities have also been named (*Geol. of Russia and the Ural*, 1845, p. 641), in two of which one diamond and in the third two diamonds were found.

Sir Roderick considers that the itacolumite of Brazil occurs in various parts of the Ural, where it was detected by Colonel Helmersen, and adds, what seems to bear upon certain conjectures previously mentioned. He says:—"We may add that as carbonaceous grits of the Devonian and carboniferous periods exist, it is very easy to conceive how these masses, like other sediments to which we have previously alluded, have been transmuted into the quartzose micaceous schists which occur in the chain, and how the diamonds have been derived from them and deposited in the auriferous gravel."

Finally, I may remark that osm-iridium found on the Cudgegong occurs in three places near the Ural, as well as in South America and in Canada, in gold diggings with which diamonds are, as we have seen, generally associated. Moreover, cinnabar found on the Cudgegong is also associated with the diamond detritus of Brazil; and as the mode of its occurrence is precisely that in which it presents itself in the Gilbert gold-field of North Queensland (as I learn from Mr. Daintree), and also in that most wonderful gold-field on the River Thames in New Zealand (as Dr. Hector has stated), as well as in Otago, *i.e.*, *not in lodes* but as a member of *drift deposits*, there is a sort of union between these and other regions in which the diamond is found. Drift or alluvial cinnabar is not less remarkable than drift diamonds; and I believe at present no lode has been detected.

In California cinnabar is said to be brought up by *solfatara* action. (Phillips in *Phil. Mag.*, Dec., 1868, p. 431). It may, therefore, be that the Cudgegong mineral is due to the action of former hot springs. The account given by Mr. A. Phillips respecting the "Chemical Geology of the Gold Fields of California" in the paper cited above, justifies the further inference that silicated waters may also have operated in coating and cementing pebbles and fragments of rocks at Cudgegong as they have done in California. He even shows that quartz veins holding gold and coloured by pyrites, as well as auriferous pyrites itself, have been formed in recent times by the action of aqueous solutions.

Diamonds in Borneo and Africa.

In the *southern* ravines of the Rotos Borneo chain, which is composed of serpentine, diorite, and gabbro, which run north and south, there is a deposit of red clay with fragments of quartz, in which spangles of gold, magnetic iron, platinum, and also *osmium* and *iridium* are met with, the whole reposing on serpentine. In this clay, on the *western* slopes, diamonds are found over fragments of sienite and diorite, and with the ores above named. Black quartz with pyrites and plates of platinum are *there* the indications of diamond, and, according to M. Louis Horner, this quartz belongs to the Serpentine. (See *d'Archiac*, vol. ii., p. 333).

So varied, yet, to some extent, so consistent with each other, are facts connected with the history of the diamond. That its mode of production in all countries may have been the same is very probable; but that origin, it must be said, obtains little illustration from the various geological conditions with which it is associated. Perhaps this very variety, whilst setting dogmatism at defiance, may serve as encouragement to the close observation of practical prospectors.

Of African diamonds we have only heard much of late. Knowing that they are generally found with gold, and that Africa contains numerous auriferous regions, it might have been anticipated that diamonds would have had a greater celebrity in that vast country, forming a quarter of the globe, than they have had in modern time.

But though Heeren has shown that there was a considerable trade among the ancient Carthaginians in diamonds brought from the interior of Africa, the only record I can find in modern times of the existence of diamonds in that part of Africa is of three shown at the Exhibition of the produce of Algiers. They were found in the Goumel River, in the province of Constantine, and were given up in payment to M. Peluzo, the Sardinian consul at Algiers, by an Arab who wished to know their value, saying that they were found in the sand of the Goumel River, with gold. One of these is deposited in the School of Mines at Paris; the second was purchased by M. Brongniart for the Museum of Natural History; and the third by M. de Drée. The Arab had several others. M. Rozet says, however, that he had acquaintance with the jewellers of Algiers, and had never heard of diamonds found in the province. The facts stated are on the authority of Dufrénoy and the Secretary of the Geological Society of France.

In Southern Africa diamonds were reported to have been discovered in 1867. After the announcement of the new find, Mr. Gregory, a well-known London mineralogist, who went to Africa on behalf of the great diamond merchant, Mr. Emanuel, sent to the editor of the *Geological Magazine* (December, 1868) an article denying the statement, and declaring it a "hoax," "imposture," or a "bubble scheme." To this Dr. W. G. Atherstone, F.G.S., a resident of Graham's Town, Cape of Good Hope, replied (May, 1869) refuting the charge, and declaring that twenty-one diamonds were known to have been found either on private or Government land, and thirteen of these were bought by persons of credibility, one of them the Governor of the colony, and another by a lapidary. Dr. Atherstone contradicts Mr. Gregory's account of the geology of the district, the latter asserting that all the rocks are igneous or their derivatives, and the former declaring that the rocks are fossiliferous, of the *Dicynodon* beds (which, by the way, brings them into relation with some of our Australian rocks); and that Mr. Wyley (an accepted geological authority) had, years before this controversy, shown that there was an intimate relationship with the Indian diamond region of Bangnapilly, and that Dr. Shaw had described the African district in the *Graham's Town Journal* of the 20th January, 1869, pointing out also the same resemblance.

In the *Journal of the Society of Arts*, of the 13th February, 1869, is a list of the diamonds by Mr. Chalmers;

who, as well as Mr. Radeloff, a Missionary, asserts that one of them was found near Pniel, by a Griqua.

Mr. Gregory. in answer to this reply, explains some personal remarks of his own, and admits the existence of Dicynodon relics, but *south* of the district alleged by Dr. Atherstone. And thus stood the matter till 1870. It now appears that diamonds have been found in vast quantities and that many magnificent and valuable stones have been disinterred. They are found on the surface of a calcareous conglomerate near the frontier of the Orange River territory, and are said to vary in weight from 6 to 13 carats; some of them reach 150 carats. The diamonds are accompanied by garnet, topaz, and other hard minerals.

It may be as well to state here that diamonds have occasionally been found in our sister colony of Victoria, and have been recorded by my friends, the Rev. Dr. Bleasdale, Mr. Ulrich, and Mr. Brough Smith, the latter of whom, in his recently published valuable official work on the "Gold-fields of Victoria," mentions sixty small diamonds of little value from Beechworth, taken out of, or near to, the usual "wash dirt" of the diggers, varying in weight from one-eighth to two carats and a half.

In 1865, fifteen more diamonds were also procured from the Woolshed diggings.

It is said also, that some small diamonds have been found at the Echunga gold-field S. E. of Adelaide, in South Australia.

At the present time, therefore, New South Wales is the diamond colony of Australia.

MINERALOGICAL NOTES FOR 1870.*

By W. H. WAHL.

New Minerals.—From various available sources of reference it appears that during the year 1870 about eleven new species have been added to the catalogue of minerals, with the usual abundance of new varieties. The following historical list will suffice to give a general idea of the character of the new additions.

Glaukopyrite.—Announced by Professor F. Sandberger, occurs at Guadalcanal in Spain, associated with calcite, tetrahedrite, pyrargyrite, and sulphide of antimony. It is described as occurring in rounded aggregations, which, when magnified, are found to be composed of a series of thin layers. The structure is mainly finely granular. Crystals are not sufficiently developed to be definitely determinable, but Sandberger suspects them to belong to the orthorhombic system. He also believes that he has detected twins and triplets, bearing a general resemblance to those of cerusite. The mineral is described as follows:—Lustre, metallic; colour, light lead-grey, approaching tin-white; streak, greyish-black; hard., 4; specific gravity 7·181.

The chemical examination gave the following as its constitution.

Sulphur	2·36
Arsenic	66·90
Antimony	3·59
Iron	21·38
Cobalt	4·67
Copper	1·14

The species approaches nearly to the geyerite of Breithaupt, but differs in colour, specific gravity, and in containing copper. It would fall in Dana's pyrites division as a member of his marcasite group.

Rabdionite is the name assigned by Von Kobell to a new metallic mineral, belonging to the class of hydrous oxides of which wad and asbolan are representatives. It differs, however, from the latter, which it approaches very nearly in chemical composition, in several important particulars. It is crystallised, occurring in short prisms; it has more water, and is more readily fusible. Its characteristics are described as follows:—Colour, black; matt; streak, dark brown; very soft, so that taken between the fingers it readily rubs away, leaving a stain behind.

Namaqualite.—Church describes under this name a new copper ore, from Namaqualand, South Africa. It is described as occurring in thin, fibrous masses, alternating with silicate of copper. Colour, light blue; lustre, silky; hardness, 2·5; specific gravity, 2·49. It consists mainly of oxide of copper, alumina, and water, with small quantities of magnesia, lime, and silicic acid.

Phosphorchromite—Occurs at Beresowsk upon listwänite, associated with crocoisite and pyromorphite. It occurs in spherical aggregates, the surfaces of which display minute crystal facets. Internally, the spheres are partly crystalline and partly dense in texture. The mineral is described by R. Hermann as follows:—Colour, dark green; streak, lighter; hard., 3; sp. gr., 5·80. The analysis gave:—

Plumbic oxide	68·33
Cupric oxide	7·36
Ferrous oxide	2·80
Chromic acid	10·13
Phosphoric acid	9·94
Water	1·16

Epiboulangerite.—Websky describes a new ore from Altenberg, occurring with mispickel, blende, galena, and pyrites. It occurs in needles of a dark grey colour. Though not suggested by the author, it may prove to be analogous in crystallisation to antimony glance, as it is, in chemical constitution. It differs from Boulangerite, of which it is doubtless a changed product, in containing from 21 to 22 per cent of sulphur.

Amblystegite.—G. Vom Rath gives this name to a new member of the pyroxene group containing alumina. The mineral occurs in the curious sanidin bombs from the remarkable volcanic region of Lake Laach, in the Eifel. The new mineral was long held by Wolf, the well-known historian of Laach minerals, to be an olivin, to which its crystallisation (orthorhombic) bears a close resemblance. The pyramid is, however, much more obtuse (measured over the macrodiagonal edge, it gives 125° 58½″, and the dimensions of the axes are determined to be $a : b : c = 0·97 : 1 : 0·57$). Its cleavage is described to be inappreciable; hard., nearly 7; sp. gr., 3·4; colour, brown to reddish brown; lustre, adamantine. Chemical composition:—

Silicic acid	49·8
Ferrous oxide	25·6
Magnesia	17·7
Alumina	5·05
Lime	0·15

Uranotil.—Boricky gives this name to a mineral occurring in a drusy quartz which coats the surface of feldspar at Walsendorff, in Bavaria. The character of the occurrence is in fine needles, which Von Zepharovich determines to belong to the orthorhombic system. The needles display frequently a radiated structure. Colour, lemon-yellow; sp. gr., 3·95; streak, lighter. The mineral blackens before blowpipe. Constitution:—

Uranium sesquioxide	66·752
Alumina (ferric oxide)	0·511
Lime	5·273
Silicic acid	13·781
Phosphoric acid	0·448
Water	12·616

Both in crystallographic and chemical character it approaches the uranophan of Websky.

Jacobsite.—A new spinell is described by Damour under this name. It crystallises in octahedra, which are frequently much distorted. Colour, black; lustrous, opaque; hard., cuts glass; sp. gr., 4·75. It contained, according to

* From advance-sheets of the *Journal of the Franklin Institute* Communicated by the Editor.

analysis, 4·21 per cent of peroxide, and 20·57 per cent of the protoxide of manganese. The peroxide constituent is chiefly iron. Small quantities of magnesia and zinc oxide are also present. It may, therefore, be termed a manganese spinel. It occurs at Jacobsberg, in Sweden, in crystalline limestone, associated with silvery mica and particles of native copper.

Gümbelite.—Named by Von Kobell in honour of the geologist Gümbel; is described as a greenish-white mineral, of a pearly or silky lustre; translucent, soft and flexible, and like asbestos to the touch. Occurs in Oberfranken. It consists essentially of a hydrous silicate of alumina, containing likewise a small proportion of potash and ferric oxide.

Milarite.—A new Swiss zeolite occurring in a granite rock in company with smoky quartz, orthoclase, apatite, chabacite, &c.; is described by Professor Kengott. Its crystallisation is hexagonal, the forms being small but sharp, and combinations of prism and pyramid of both orders (the polar interfacial angle of pyramid = 144° 46′ 5″). The analysis shows it to be a hydrous soda, lime, and alumina silicate. Its name is derived from its occurrence in the Val Milar. Colour, white to green; hard., 55·6.

It will be noticed that Gmelinite, which approaches very nearly in chemical character, presents a further resemblance to the mineral just described in its crystallisation, which is hexagonal (holohedric). The angle of its pyramid is 142° 25′, a variation of but 2° from the measurement which Kengott announces for Milarite.

Hessenberg describes likewise another zeolite from the volcanic region of Santorin. The crystals are short orthorhombic prisms. Before blowpipe it swells considerably and fuses readily to white glass. Prof. Hessenberg describes it as very closely resembling epistilbite. From the similarity, almost identity, of the angle of the prism (the difference scarcely amounts to 1°), it would seem highly probable that the two were the same.

Sandberger describes several new hydrated phosphates, one of which, a phosphate of lime, is analogous to the hydrated phosphate of copper, known as libethenite. The crystals are colourless, belong to the monoclinic system, and possess a prismatic habitus. No name has as yet been proposed for it.

Simonyite is a new sulphate, found in the salt works at Hallstadt, and described by Tschermak. It occurs associated with rock-salt and anhydrite, chiefly in thin layers of a bluish-green colour, presenting here and there a crystalline form, which is announced to be monoclinic. It is a hydrous magnesia-soda sulphate.

Of the numerous varieties which have been announced, the following seem to be the most interesting:—

Lithiophorite.—An ore of manganese, containing lithia. It is amorphous, occurring in thin layers; also pseudomorphic after calcite. It colours the flame intensely red. It is found in the granite of Schneeberg, Schwartzenberg, and Johanngeorgenstadt—generally coating quartz. The granite is much decomposed, and with the spectroscope gives distinct indications of the presence of lithia.

A new Olivine.—Roepper gives the following as the composition of a mineral occurring in crystals of an inch or two in length, at Sterling, N. J. It is found associated with willemite, Franklinite, Jeffersonite, and spinel.

Silicic acid	29·90
Iron protoxide	35·60
Oxide of manganese ..	16·90
Oxide of zinc	10·66
Magnesia	5·81
Insoluble	1·03

The crystals were weathered externally, but within were weathered externally, but within were bright. Colour, dark-green to black; hard., 5·5—6. A zinc deposit was obtained with the blowpipe. The crystallisation and analysis prove it to be an olivine. The proportion of zinc and manganese in its composition make it a most interesting variety.

The same author describes a *manganese dolomite*, from or near the same locality. It is a rosy-red mineral, occurring in a vein of apple-green willemite. It possesses distinct rhombohedral cleavage. Hardness = 4; sp. gr., 3·05. An analysis gave as much as 43·5 per cent of carbonate of manganese, 50 per cent of carbonate of lime; the remainder consisting of carbonate of iron and magnesia. Accordingly Roepper characterises it either as a dolomite in which the magnesia has been replaced almost entirely by manganese, or a diallogite, in which a large proportion of the manganese has been replaced by lime.

Hallite, a micaceous (or chloritic) mineral from Chester county, Pennsylvania, has been announced by Leeds. It is flexible, of a brownish colour, and occurs in plates of various sizes. It is believed to possess distinguishing optical properties, though no investigation of the subject has yet appeared.

Metacinnabarite.—G. E. Moore has announced the occurrence, in Lake county, California, of an amorphous sulphide of mercury in a siliceous gangue, in company with cinnabar. It frequently covers crystals of pyrites, and is filled with small cavities in which are found crystals of cinnabar. The colour is greyish-black; streak on porcelain, pure black; hard. = 3; sp. gr., 7·7. It gives all the reactions of cinnabar, with which it is identical in composition. The author very properly identifies it as the variety of sulphide obtained in the laboratory as an amorphous black powder, upon precipitating a soluble mercuric salt. He proposes the name given above to designate the variety.

A LECTURE EXPERIMENT.*

A NUMBER of devices, some of them simple, others complex, have from time to time been described for showing the reciprocal combustion of the elements of water, and experiments of a similar nature.† Most, if not all of these, however, as will be found upon testing, either do not entirely remove the danger of an explosion from the operator, or they require the exercise of an unusual amount of care and dexterity to be used with success.

The accompanying arrangement, which is of the most simple character, and which we saw for the first time on the lecture table of Professor Himes, we have since repeatedly used to show the burning of oxygen, air, chlorine, &c., in hydrogen, burning gas or hydrocarbon vapours. The experiment can be performed with such ease that is worthy of notice.

The arrangement consists of a cylinder of glass, about a foot or a foot and a half in length (the kind used commonly as chimneys for the argand-burner can be had of proper length). This is furnished above and below with a cork; the one at the upper end has one, that below has two, glass tubes of the form shown in figure. The whole affair is supported from the retort stand. The hydrogen (in the H and O experiment) is admitted through the upper tube, when it has completely displaced the air it is ignited below—the cork having been removed—and the

* From advance-sheets of the *Journal of the Franklin Institute.* Communicated by the Editor.

† *Ber. d. Deutsch. Chem. Gesel.*, iii., pp. 419, 930; *Journal of the Franklin Institute*, lxi., 210.

supply is regulated until only a weak hydrogen flame remains. The oxygen supplied through the straight tube in the lower cork, is now turned on slightly, and the cork fitted into its place. The flame of hydrogen at the opening is extinguished, but the oxygen, in passing up through it, is ignited, and burns now in the centre of the cylinder. The surplus of the hydrogen escapes now from the second tube below, and can be there ignited. This last flame serves the purpose of a good indicator, by which the supply of gases in the cylinder can be regulated, and which, of course, leaves the size of the flame at the will of the operator. Once in operation, the experiment may be left to take care of itself for the remainder of the hour.

ON J. STODDART'S PLAN OF CONCENTRATING SULPHURIC ACID BY MEANS OF HEATING AND BLOWING AIR THROUGH THE ACID.

By F. BODE.

THE author, having seen in the first number for June of *Dingler's Polytechnisches Journal* a translation of the short paragraph, written by M. J. Stoddart, and published at page 167, vol. xxiii., of the CHEMICAL NEWS, has sent to us a loose sheet taken from *Dingler's Polytechnisches Journal* (first number for July), with the request that a translation should be made of the following lines containing observations on the plan of M. Stoddart, only briefly set forth *loco citato*.

F. Bode says:—The boiling-point of sulphuric acid at 60° (1·7 sp. gr.) lies between 190° and 200°, but an acid of the strength just indicated is always obtained when it is run off from the pans at a temperature of from 185° to 190°; according to Stoddart, it would only be necessary to raise the temperature 40° less than is otherwise required. Stoddart has not communicated, in his very brief notice, what saving of fuel and of labour his process yields, as compared with the process in ordinary use. When the pans are well and rationally constructed, and the fire-place properly arranged, 1 cwt. of 60° B. acid may be obtained from acid at 50° by the combustion of from 16 to 18 lbs. of coals of average quality; although the author (F. Bode) knows quite well that in many instances, owing to badly-constructed fire-places and pans not well arranged, as much as double this quantity of fuel is required for the production of the same effect. It would require the setting forth of a great many conditions to enable me to say how much fuel is required to heat acid already at a temperature of 150° further to 190°; but it is clear that the less expenditure of fuel, resulting from having only to heat to 150° instead of to 190°, would not bring on any real gain obtainable from the new (Stoddart's) process. Next comes the point that the air to be blown through the hot acid has to be compressed, even though it be only feebly. By passing through the acid, the air will become hot, and thereby acquire the property of taking up more aqueous vapour than it can take up while cold; but the heating of the air necessarily causes the cooling of the acid, and this loss of heat has to be met by the expenditure of a fresh quantity of fuel. The blowing of air through the acid will either require expenditure of fuel or manual labour not required by the usual mode of concentrating the acid. I should, however, observe that the withdrawal of heat by the blowing through of air may, under certain premises, be rendered very small. In order to make the air which is forced into the acid take up as much water as possible, that air should be brought largely into contact with the acid, and should become as warm as possible; but this arrangement necessarily involves a high column of liquid for the air to pass through, consequently the use of a very deep pan. The pans now generally in use for concentrating acid to 60° B. are generally not filled deeper with acid than to a height of 0·35 metre, and, for the blowing of air through the acid, this height appears rather too small; yet the construction of pans of greater depth is not to be recommended, for a great many reasons. In the first place, deep pans containing a high column of acid will require (since the pans are made of lead, which is apt to bend and give way, by becoming hot, under the weight and pressure of the acid), to be supported at the bottom all over. This support, although best made of cast-iron plates, is often simply made of slabs of burnt fire-clay; but these slabs, in the first place, prevent the ready transmission of the heat from the fuel to the pan and the acid therein contained: moreover, these slabs not only absorb and retain heat which is not utilised, but they interfere with the giving off of the heat of the gases of the combustion to the pans, and thereby cause that, if pans are constructed so as to yield, in a given time, a certain quantity of acid of 60° B., either a larger number of pans will be required (under the conditions alluded to), or a pan will have to be made so as to be exposed to a larger surface of fire. These considerations apply to deep pans, and so do the following:—The destruction of the lead of which the pans are made is generally observed to take place chiefly, if not exclusively, at the bottom, unless, indeed, exceptionally, either from defects of the lead or from construction. There is no reasonable ground to suppose that, of two pans of equal size at the bottom, the pan with greater depth and consequently higher column of acid therein, should last longer than a shallow pan, and we must therefore assume the durability of each of these pans to be the same; but it is then clear and evident also that a shallow pan will be, in a given time, more advantageously worn, because the weight of lead contained in the sides of such a pan is less. In order to guard against the spirting of acid, and, consequently, loss, when air is blown through it, the pans will have to be covered, or at least a hood will have to be placed over it; even with the pans now in use, it frequently happens that, as soon as the acid becomes more concentrated, particles of acid are driven off along with the aqueous vapour, as is readily perceived by the action of the latter on the skin. When sulphuric acid is forced up by means of compressed air, and the latter allowed to blow off, after the *monte-acide* has been emptied, it will be observed that, even before all the acid has been discharged, but the stream thereof issuing from the discharge-pipe becomes less bulky and already mixed with air-bubbles, a more or less strong cloud appears at the mouth of the pipe; which cloud is readily perceived, by its action upon the skin of the face and hands, to be sulphuric acid in finely divided state, and some of it follows along with the air while blowing off after not a drop more of acid is discharged from the mouth of the pipe. When air is forced through sulphuric acid contained in covered pans, a similar effect will ensue, and the consequence will be that a large portion of the acid thus carried off in vesicular shape by the air will be lost. Supposing the air blown through the hot acid to be warmed from 0° to 100°, and to become saturated with as much water as air of the last-named temperature will bear, 1 cubic metre of such air will absorb 295 grms. of aqueous vapour, which quantity is therefore withdrawn from the acid. One cubic metre of air at 0° weighs 1·2991 kilos., and the specific heat of air is 0·2669; by the heating of 1 cubic metre of air from 0° to 100° the acid will loose—

$$1{\cdot}2991 \times 100 \times 0{\cdot}2669 = 34{\cdot}67 \text{ units of caloric.}$$

I now leave out of the question whether or not a larger consumption of heat takes place, owing to the fact that the water present in fluid state (in the acid) assumes the gaseous (vapour) form. In order to evaporate 1 kilo. of water we require, according to what has just been stated, $\frac{1000}{295} = 3{\cdot}39$ cubic metres of air to be blown through the acid, and the withdrawal of heat (caloric) amounts, therefore, for every kilo. of water evaporated, to:—

$$34{\cdot}67 \times 3{\cdot}39 = 117{\cdot}53 \text{ units of caloric.}$$

By removing 1 kilo. of water from sulphuric acid at 50° B., we obtain 4·25 kilos. of sulphuric acid at 60° B., and the quantity of heat (caloric) withdrawn amounts for the kilo. of acid at 60° B. to—

$$\frac{117·53}{4·25} = 27·66 \text{ units of caloric.}$$

It cannot be said that these figures bear unfavourably upon the process under discussion, and even when more unfavourable premises are assumed, this does not alter the case. Supposing the heating of the air blown or forced through the hot acid to extend only to 50°, 1 cubic metre is saturated with 63·6 grms. of aqueous vapour, and, in order to obtain an evaporation of 1 kilo. of water, $\frac{1000}{63·6} = 15·72$ cubic metres have to be applied, which, by becoming heated to 50°, will withdraw from the hot acid:—

$$1·2991 \times 50 \times 0·2669 \times 15·72 = 272·52 \text{ units of caloric.}$$

The loss of heat for acid at 60° will, in this case, amount to 64·1 units of caloric. Stoddart intends to apply this same process, also, to obtain acid at 66° B., the only difference being that in this case the acid has to be heated to 260°. The question may be reasonably asked whether or not, at this temperature, and with so strong acid, the leaden pans will not be rapidly destroyed, and the acid so strongly contaminated with lead as thereby to become unfit for many uses.

The author of this paper does not for a moment suppose that Stoddart has not made careful researches before bringing his process into practical use at the Uphall works, but since, from the very short and incomplete notice Stoddart published in the CHEMICAL NEWS, no precise information about the process can be obtained as to its practical bearing, the above observations have been written with a view to obtain what, to those interested in this subject on the Continent,—and, among them, the author of these observations,—will be highly gratifying—a more complete account of Stoddart's process, with every particular relating to it.

NOTICES OF BOOKS.

A Practical Treatise on the Manufacture of Soaps. By CAMPBELL MORFIT, M.D., F.C.S., formerly Professor of Applied Chemistry in the University of Maryland. London: Trübner and Co.

SOAP-MAKING, until lately, has not advanced equally with other branches of industrial chemistry. There has been much empiricism in the methods of operation, amounting at times to so great a defect that no uniformity could be obtained even in batches of soap from the same maker. This state of things in an art so important in both its scientific and commercial bearings, naturally attracted the attention of some of our foremost chemists, and, as a consequence, are the many exquisite soaps produced during the last few years. One of the first to commence laboratory researches was the author of the work here noticed, who in 1856 introduced his system of oleic soap manufacture, subsequently substituting sal-soda fused in its water of crystallisation or the powdered sal-soda—

$$(NaO,CO_2,10HO)$$

and semi-dehydrated sal-soda ($NaO,CO_2,5HO$) before used, thereby reducing the salt to the necessary state of fine division without mechanical means or labour. In continuing his researches Dr. Morfit now presents to the public a handbook of soap manufacture founded on the four following principles:—

(1). The saponification of the fat acids generally, whether singly or intermixed among themselves, or with rosin, and their conversion into soap by means of alkaline carbonates, either with or without the direct use of water.

(2). The management of the water of constitution of the soap in a manner quasi-chemical, by which it is made, comparatively, a permanent ingredient.

(3). The use of carbonate of soda of different degrees of hydration, as a means of apportioning the water and alkali in the soap.

(4). The instantaneous manufacture of soap, hard and soft, without the use of caustic leys, and upon a definite plan by which the amount and composition of the product may be deduced in advance from the quantity of the materials employed.

In order to bring his work within certain limits, Dr. Morfit has confined himself to thorough instruction in the more practical bearings of the acid derivatives of neutral fats upon the manufacture of soaps, and more exclusively to the employment of crude oleic acid, olein, and fat acids generally, as soap-stock, in place of tallow, palm-oil, and similar neutral fats. This has been done to bring into commercial consideration the utilisation of the by-products of the manufacture of stearic candles, the clarification of oils, &c., these constituting an increasing source of material for which, at present, there is but a limited demand, the price being much below that of tallow. These reasons are worthy the full consideration of the soap-maker, for the market for crude oleic fats in England is never exceedingly active, and, besides, these fats cannot be utilised for illuminating and lubricating purposes, whereas there is a steadily increasing demand for tallow and the more consistent neutral fats. Dr. Morfit treats the subject very fully; the raw materials, the arrangement of the factory, the process, have each a distinct consideration. Dr. Morfit's long practical experience renders the advice detailed with respect to the best factory plant and its cost of high value, while the several apparatus are elucidated by large sectional and perspective diagrams. After the arrangement of the plant there follow numerous formulæ for the various soaps, and an estimate for the actual expense per month for working a soap-factory. Finally, there is a clearly written chapter conveying instructions in the chemical analysis of soap. Dr. Morfit advises the weighing out of 100 grains of the soap to be tested, and the solution of this quantity in alcohol, aided by the heat of a sand-bath. The solution is then to be filtered, and the alcohol of the filtrate evaporated; the filter with the residuum being heated to dryness, the constant weight, less that of the paper, expresses the percentage of foreign matters as well as of free alkali in the soap. The proportion of free alkali is determined by the quantity of normal acid liquor required to redden the blue litmus test paper; while the quantity of combined soda (NaO) is estimated from the evaporated filtrate in the same manner, the acid employed in this test serving to separate the fat element, which floats at the surface of the liquor, and may be collected in wax. As related to the manufacture of soaps, a chapter is appended on the constitution of lubricating compounds for railway and common waggon uses. The matter in all parts of the book is carefully illustrated with woodcuts, the type is large, and the arrangement admirably adapted for easy reference; the utility of the work is beyond question.

Mineral Statistics of Victoria for the year 1870. Presented to both Houses of Parliament by His Excellency's command. By authority: John Ferres, Government Printer, Melbourne.

Reports of the Mining Surveyors and Registrars; quarter ending March 31st, 1871. John Ferres, Government Printer, Melbourne.

THE publications, of which the titles are above quoted, contain, as may be inferred from these titles, a very large amount of highly useful and practical information on a subject interesting, not only to those who reside in Victoria (formerly a portion of South Wales, known as Port Philip district, but erected into a separate colony by the Act 13 and 14 Vict., cap. 59), but also to the rest of the civilised inhabitants of the globe, on account of the great influence the gold production of this Colony exercises upon trade

industry and everything connected therewith or dependent thereupon. Not only are gold, silver, and diamonds* found in Victoria, but antimony, copper, coals, tin, manganese, lead, slate, and building stones, are referred to in the papers before us. From the laboratory report appended to the first-named paper—we cannot call it a blue-book because it is not dressed in the garb of that colour—and written by Dr. C. Newberry, we abstract the following particulars:—"The only novel or unusual occurrences of gold which have come under my notice during the year have been some specimens from the Empire Company's claim near Landsborough, in which gold occurs associated with native silver and copper, chloride of silver, carbonates of copper and lead, and oxide of iron in a micaceous sandstone, through which pass thin veins of ferruginous quartz; three samples of the metal obtained by the miners from this stone gave the following results in 1000 parts:—

	I.	II.	III.
Gold	197·44	517·442	189·65
Silver	755·57	460·272	768·63
Copper, Lead ..	46·99	22·286	41·72
	1000·00	1000·00	1000·00

The only new compound of gold which has been received was one containing 56 per cent of gold, and 44 per cent of arsenic. The alloy was of a yellowish-grey colour, brittle, breaking with a crystalline fracture. Dr. Newberry suggested that this alloy was not a native product, but accidentally formed in a roasting kiln, but the manager of the mine where the alloy alluded to was found distinctly states that the specimen is native, as he obtained it from the quartz. Several specimens of fossil trees, fruit, leaves, seeds, and other fossil vegetable matter exhibiting organised structure have been found in a locality named Haddon, and some of these are described and illustrated with very well executed lithograms (so it reads in the original), by Dr. F. Von Mueller, Director of the Botanic Gardens, and Government Botanist at Melbourne. The Colonial Government of Victoria may be congratulated upon the excellent manner in which the reports herein alluded to are made up under its care by men evidently well up to their work.

MISCELLANEOUS.

The Bancker Collection.—For many years past there has existed in Philadelphia, and known only to those of its citizens more especially interested in scientific pursuits, a collection of philosophical and chemical apparatus unequalled in this country, and, if the opinion of foreign *savans* be taken, without a rival in the world. It was made and owned by the late well-known Charles N. Bancker, Esq., who devoted all the leisure hours of a life extended far beyond the average lot of man, and constantly applied to the successful prosecution of business, to the cultivation of scientific knowledge. For more than half a century he imported from the workshops of Europe their choicest productions in the way of apparatus; and his interest was not limited to one, but extended to all the sciences embraced within the scope of philosophic inquiry. In this collection will be found cabinets of minerals, with beautifully executed models in glass and wood, to exhibit the immense variety of crystalline forms; charts and maps in relief, with suites of rocks, to illustrate the geology of various countries; telescopes and instruments for observing the stars, with orreries and globes for studying the motions of the heavenly bodies; models of pumps, rams, jets, mills, and all manner of contrivances to demonstrate the properties of fluids when in rest and in motion. The collection also contains magnets, simple and compound, with machines of the most varied description, to illustrate the phenomena of electricity and magnetism. But above all, it is rich in optical and acoustic apparatus. The Abbé Moigno, a distinguished French *savant*, wrote of it some years ago in *Cosmos*, that "this collection of optical instruments is certainly the most extensive and most brilliant that exists in the world. It embraces in itself more riches than all our cabinets of France, and perhaps of Europe, united. And its founder, whose zeal seems to grow with his age, does not cease to gather the freshest novelties. We exaggerate nothing when we estimate the optical treasure of Mr. Bancker at many hundred thousand francs. Besides illustrating the history of optical discovery and research during the present century, it contains numbers of the most valuable and efficient instruments, such as the saccharimeter of Duboscq, the polarising apparatus of Dove, Powel, and Soleil, microscopes by Zentmayer, Smith and Beck, &c., and complete sets of apparatus and objects for repeating the researches of Becquerel and Stokes on phosphorescence and fluorescence. Professor Henry, President of the Smithsonian Institution at Washington says in a recent letter:—'I am free to say, that, with the addition of a very few articles that have been improved or invented within the last few years, it would be the most complete series of instruments that I know of for the illustration of the phenomena and history of physics. To break up the collection and dispose of it piecemeal, would be a matter of much regret, since the value of the instruments is enhanced by the fact of their being part of a series well adapted to the illustration of the order of the development of science.'" Fortunately for the interest of science, the wish of Professor Henry has been, to a great extent, realised. The entire collection of optical and acoustic apparatus has been purchased by Professor Morton on behalf of the Stevens Institute of Technology, at Hoboken, and is now thrown open to all the students who may wish to prosecute researches within the walls of that great institution.—*Journal of the Franklin Institute.*

* As yet only 75 in all have been found in this country, and among this number few of great value, while a systematic search for these stones proved in 1870 a complete failure.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, July 10, 1871.

This number contains the following papers relating to physico-chemical and collateral sciences:—

Action of Electricity upon the Coloured Tissues of Plants.—M. Becquerel.—This very lengthy essay contains the record of a series of experiments made by the eminent author in order to illustrate the action of electricity upon the living organism of plants.

Freezing of Water.—M. Boussingault.—After briefly referring to the experiments of the Florentine Academicians, and of Huyghens (1667), on the force exerted by the freezing of water in closed metallic vessels, the author relates a series of experiments made by him last winter in order to ascertain whether water, when put into a strong vessel (a steel cylinder of great strength, and so arranged that the dilatation, or expansion, of the water, when cooled below +4·1°, could be prevented), would or would not remain liquid, even when exposed to a cold very considerably below its point of congelation, in consequence of the expansion due to the cooling down from below +4·1° being prevented by the strength of the vessel containing the water and stopper (steel plug) fitted thereto. The result of this investigation was found to be that water remains liquid under the conditions alluded to, even at a temperature of −18°, but freezes instantaneously; as soon as the impediment, caused by the resistance of the plug which hermetically closes the steel vessel, was removed, free play was given

to the expansion of the liquid. It should be noted that the sides and bottom of the steel vessel alluded to were of such great strength as to be practically unyielding.

Sample of Incinerated Paper found among the Ruins of the recently burnt Ministry of Finance, at Paris.—E. Chevreul.—The author first exhibits to the assembly a lump of material more resembling a mineral than what it really is, the ash of paper burnt during the fire at the Ministry of Finance (purposely ignited and fired by the Communists). He next takes this opportunity to call attention to some points of the difference between the paper sized by the old and by the new process (hand-made and machine-made); the main fact being that, whereas in the hand-made and hand-sized paper the sizing (glue and alum) is only on the surface, the machine-made paper is sized in the paper mass (pulp) itself by the aid, partly of mineral, and partly of organic matter (resin and starch). These are all insoluble in water, and require, for their intimate incorporation with the pulp, that the latter be far more finely divided, to the detriment of the strength of the paper, as evidenced by the fact, for instance, that it does not stand folding without cracking and readily tearing. This, moreover, causes an essential difference in respect of the writing made on such machine-sized paper, which writing is by far more liable to be effaced, owing to not penetrating sufficiently into the mass and body of the paper. The author further observes, that upon the old-fashioned hand-made paper, sized with aluminated glue, indelible writing may be made with indian ink, finely divided, suspended in weak hydrochloric acid (sp. gr., 1·007); whereas, for the same purpose, the machine-sized paper requires the indian ink to be mixed with very weak caustic soda solution (same sp. gr. as just alluded to).

Manner in which the Mineral Constituents of Beet-Roots are Distributed in that Vegetable.—B. Corenwinder.—The fifth portion of the exhaustive memoir "On the Chemistry of Beet-Roots."

Method of Preparing Trichloracetic Acid.—A. Clermont.—The main gist of this paper is, that trichloracetic acid is readily obtained by causing hydrate of chloral to be acted upon by fuming nitric acid. The mixture, containing three times as much, by weight, of the acid as the quantity of hydrate of chloral, is first left exposed to direct sunlight for a few days, and afterwards submitted to distillation.

Dambonite and Nitrated Dambose.—P. Champion.—In the introduction to this paper, the author records, with a few words, that dambonite is a peculiar substance found recently by Aimé-Girard in the caoutchouc from Gabon, which substance is converted, by nitro-sulphuric acid, into nitrated dambonite, an explosive material; while dambose is obtained from dambonite by the action of hydriodic acid, the dambose thus prepared yielding, with nitro-sulphuric acid, also a nitrated compound, which explodes. The main portion of this essay is devoted to the description and mode of preparation of the following substances:—Bromhydric erythrite, $C_8H_8Br_2O_4$, obtained by treating erythrite in a sealed tube at 110° for a period of thirty hours along with a concentrated solution of hydrobromic acid; the body alluded to is a solid crystalline substance, insoluble in water, and fusing at 130°. Nitro-bromhydric erythrite, $C_8H_8Br_2O_4(2NO_4)$, obtained by treating the before-mentioned substance with nitro-sulphuric acid (1 part nitric, and 2 parts sulphuric acid, both concentrated); this compound is insoluble in water, fuses at 75°, is not explosive, and readily decomposed by heat. Nitro-chlorhydric erythrite, $C_8H_8Cl_2O_4(NO_4)$, a solid body, crystalline, soluble in alcohol, and fusing at 60°.

July 17, 1871.

The original papers relating to chemistry and collateral sciences contained in this number are—

Description of a Magneto-Electro Machine which produces a Continuous Current.—M. Gramme.—Illustrated by woodcuts.

Compressibility and Expansion of Gases.—M. Amagat.—The contents of this paper do not admit of any useful abstraction, owing to the fact that this would require the reproduction of a large number of tabulated results of experiments.

Existence of Nitrous Acid in Arable Soils, and on the Functions of that Acid therein.—M. Chabrier.—From this very lengthy monograph, we learn that nitrous acid is constantly present in soil, that this acid is partly converted into nitric acid, partly into other nitrogenous compounds. The average quantity of that acid found in the soil of market gardens amounts to 4·52 parts; corn-bearing soil, 2·16; orchard soil, 1·51; soil bearing fir-trees, 0·75 parts; while a soil named safre (dried slime deposited by the river Durance) was found to contain no nitrous acid at all. It appears that the quantity and quality of the water which impregnates the soil has a great deal to do with the presence therein of the acid just alluded to.

Artificial Production of Dulcite.—G. Bouchardat.—By treating inverted milk sugar with sodium amalgam (containing 2·5 per cent of sodium), the author has obtained a substance, $C_{12}H_{14}O_{12}$, solid, crystalline, not capable of fermentation, fusing at 187°, difficultly soluble in strong alcohol and in cold water. This body, therefore, appears to be identical with the dulcite obtained from Madagascar manna, and the substance found in the juice of the *Metampyrum nemorosum*.

Fermentation and Alcoholic Ferments.—M. Dubrunfaut.

Observation on Dynamite.—P. Guyot.—The more important part of this communication is that, instead of paper, parchment is used for making the cartridges filled with dynamite (see CHEMICAL NEWS, vol. xxiv., p. 21), so that no nitroglycerine can escape by soaking the paper, parchment being impervious to the liquid just alluded to.

Crystallised Aconitine.—H. Duquesnel.—This paper contains, in the first place, an exhaustive description on the best method of preparing aconitine in crystalline state for pharmaceutical purposes, and next a detailed account of the properties of the alkaloid alluded to. Crystalline aconitine, $C_{34}H_{40}NO_8$, is nearly insoluble in water, even at 100°; the substance is not volatile, but heated to above 130° is decomposed. Aconitine is soluble in alcohol, ether, benzine, and chloroform; insoluble in glycerine and petroleum oils. Aconitine readily forms salts with acids, and is even soluble in water impregnated with excess of carbonic acid. Although phosphoric and tannic acids, as also the double iodide of mercury and potassium, are tests for aconitine, they are not reliable unless taken in combination with its physiological effects.

July 24, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Crenic and Apocrenic Acids contained in the Mineral Waters of Forges-les-Eaux (Seine-Inférieure).—C. Bontigny.—This lengthy essay treats on the presence of proto-crenate of iron in the mineral water just alluded to, and on crenic and apocrenic acids, about which, however, nothing new is stated, the author merely drawing attention briefly to Dr. G. J. Mulder's excellent investigation on this subject. It appears that the acids alluded to are formed, in the instance of the water here mentioned, by the decomposition of organic (decaying vegetable) matter, while the iron is due in this instance to a vein of pyrites. The proto-crenate of iron is soluble in water; but that solution is instantaneously decomposed by contact with air, and hence an ochrey deposit is always found near springs, and in brooks and ditches containing the salt alluded to in solution, which salt cannot be obtained in dry pure state by any process. Crenic and apocrenic acids were first discovered by the late Berzelius in the water of Porla, Sweden.

Second Memoir on the Presence of Nitrous Acid in Mud (Slime from Rivers) and in Water employed for Irrigation.—M. Chabrier.

Researches on the Action which is Exerted by the Substances which Aid the Decomposition of Chlorate of Potassa when employed for making Oxygen.—E. Baudrimont.—The conclusions drawn from the author's researches are—(1) That chlorate of potassa is evidently an endothermic compound; (2) that the decomposition of that salt into oxygen and chloride of potassium, by the aid of certain oxides (CuO, MnO_2, &c.), is simply due to the effect of contact; (3) that the phenomenon of incandescence, which accompanies the decomposition of this salt in the presence of the oxides alluded to, is due to the sudden expulsion of the caloric of formation (*calorique de formation*) of that salt; (4) that chlorate of potassa, while in contact with the oxides of copper or manganese, possesses the property of becoming liquefied below its ordinary melting-point.

Quantity of Caloric Set Free during the Formation of Organic Nitrated Compounds.—Dr. Berthelot.—This exhaustive memoir treats on nine different compounds, viz.:—Nitric ether, nitroglycerine, nitro-mannite, gun-cotton, xyloidine, nitro-benzine, binitrobenzine, chloro-nitrated benzine, nitro-benzoic acid. The investigation of the author has been mainly directed to ascertain the amount of caloric set free during the formation of these substances.

Fermentation and Alcoholic Ferments.—M. Dubrunfaut.

New Theory of Fermentation.—A. Petit.—The contents of these papers, however valuable in a scientific point of view, are not suited for useful abstraction.

Estimation of Free Hydrofluoric Acid.—P. Guyot.—The author proposes to apply, for the purpose alluded to, the reaction between fluoride of potassium and sesquichloride of iron, yielding a white-coloured precipitate of sesqui-fluo-ferrate of potassa, $Fe_2Fl_3 2KFl$, the reaction taking place according to the following formula:—

$$Fe_2Cl_3 + 5KFl = Fe_2Fl_3 2KFl + 3KFl.$$

The liquid, which contains free hydrofluoric acid, is first exactly neutralised with pure carbonate of potassa, and next, after filtration, a titrated solution of perchloride of iron is added.

This number contains also several important meteorological, astronomical, and physico-geographical papers and essays.

Les Mondes, July 20, 1871.

This number contains the two following original papers relating to physico-chemical sciences, but, both being accompanied by woodcuts absolutely required for the proper understanding of the subject, we only quote the titles:—

Magneto-Electric Machine which Produces Continuous Currents.—M. Gramme.

Support with Total Reflection for the Projection of Moving Images.—J. Duboscq.

A large number of pages of this number are devoted to a subject of public and political economy on—

Taxation by One Single Impost—C. Tellier—Which certainly deserves the serious study of political economists and others, the main and very important points being that the author's proposals tend to create the most simple, most productive, and most equitable tax.

Moniteur Scientifique, Nos. 349 and 350 (double number), July 1 and 15, 1871.

This number contains the following original matter relating to chemistry and allied sciences:—

Processes for Detecting, Distinguishing, and Separating from each other Silk, Wool, and Vegetable Fibres in Mixed Woven Fabrics.—Dr. E. Kopp.—This lengthy memoir contains, in

a condensed form, all the information on this subject found dispersed in various published works, including, also, the various methods employed on the large scale for separating animal and vegetable fibres from each other when they occur in mixed fabrics. From the contents of this paper we cannot make any general abstract; but among some of the particular reactions we find the following for detecting wool in silk, and *vice versâ*, based upon the fact that wool contains sulphur, while silk does not. The tissue to be tested—it should be, however, white, not dyed—is put into a solution of caustic potassa or soda, wherein, previously, oxide of lead has been dissolved; woollen fibres become black when immersed in this liquor, whereas silk remains unchanged. Another test for the same purpose is ordinary nitric acid, which dissolves silk in the cold, but hardly affects wool.

Changes which the Progress of Modern Chemistry has wrought in Therapeutics and Hygiène.—F. Papillon.—This exhaustive monograph is divided into the following chapters:—General action of medicaments upon the human system; alkaloids; anæsthetics; disinfectants, antiseptics, antimiasmatics; phenic acid; iodine, bromine, and compounds thereof; acids and mineral salts; artificial essences.

The American Journal of Science and Arts, July, 1871.

This number contains the following original papers and memoirs:—

Some Phenomena of Binocular Vision.—J. Le Conte.—The continuation and fifth part of the author's essay on this subject. This portion, copiously illustrated with woodcuts, treats on stereoscopic phenomena.

Three Masses of Meteoric Iron from Augusta County, Virginia.—J. W. Mallet.—The author describes, and illustrates by means of woodcuts, three specimens of meteoric iron found in the county above named. The sp. gr. at 15° of these samples was respectively found to be 7·853, 7·855, and 7·839. The composition of the substances was ascertained to be, in 100 parts, the following:—Iron, 88·706, 88·365, 89·007; nickel, 10·163, 10·242, 9·964; cobalt, 0·396, 0·428, 0·387; copper, 0·003, 0·004, 0·003; tin, 0·002, 0·002, 0·003; manganese, a trace in two out of the three samples; phosphorus, 0·341, 0·362, 0·375; sulphur, 0·019, 0·008, 0·026; chlorine, 0·003, 0·002, 0·004; carbon, 0·172, 0·185, 0·122; silica, 0·067, 0·061, 0·056;—totals, 99·872, 99·659, 99·947. The chlorine, the author states, is not an essential constituent of the original masses, but has been derived from the soil in which the iron has lain imbedded.

Application of Photography to the Determination of Astronomical Data.—A. Hall.—An important astronomico-physical essay.

Ralstonite, a New Fluoride from Arksut-Fiord, Greenland.—G. J. Brush.—The mineral is colourless to white, with a vitreous lustre, crystalline in octahedra; hardness equal to about 4·5; sp. gr., 2·4. When heated in a test-tube, the mineral whitens, yields water at first, then gives off fumes and a copious white sublimate, while the walls of the tube are etched; the vapour in the tube, as well as the water, exhibit an acid reaction. Heated before blowpipe-flame, the mineral whitens without fusion, and colours the flame a soda-yellow; heated with cobalt solution, a bright alumina blue appears. In salt of phosphorus the substance was readily dissolved, giving a colourless bead. The mineral was, on examination with a magnifier, found to be so intimately associated with thomsenolite, that it was deemed impracticable to separate a sufficient quantity for anything more than a preliminary qualitative investigation in the wet way, which led to the result that the mineral is essentially a hydrous fluoride of aluminum, with probably a small amount of calcium and sodium. Its isometric form and its infusibility distinguish it from all other fluorides yet described as occuring at the cryolite locality in Greenland. The only mineral which, in general chemical characters, approaches it is the fluellite from Stenna-Gwyn, in Cornwall, a rare mineral which, according to Wollaston, is a fluoride of aluminum.

Atomic Weights of Cobalt and Nickel.—R. H. Lee.—Reserved for complete reproduction, an observation also applicable to the following paper.

Note on the Spectrum of the Corona.—C. A. Young.

Jahrbuch der Kaiserlich-Königlichen (Austro-Hungarian) Geologischen Reichsanstalt, No. 1, 1871.

In addition to a large number of strictly geological papers and memoirs, this number contains—

In Memory of Wilhelm Haidinger.—F. Ritter von Hauer.—An excellent biography of the lately deceased celebrated *savant* just named.

Studies on the Saline Region of Siebenbürgen (Transylvania).—F. Posepny.—The second section of a lengthy memoir containing a very large number of results of chemical analysis of the water of saline springs, and of the produce of various layers and deposits of rock-salt and of various mineral waters met with in the country alluded to.

Polytechnisches Journal von Dingler, second number for June, 1871.

The original papers and memoirs relating to chemistry and collateral sciences are the following:—

Analysis of a Sample of Universal Manure (Universal Dünger).—Dr. H. Vohl.—Under this name, the firm Hesch, at Enderrich, near Bonn, has for some years sold an artificial manure which exhibits a yellowish-grey colour, is acid to test-paper, does not give off any strong smell, and is composed, in 100 parts, of—Water, 14·714; residue left after ignition, 58·593; loss by ignition, 26·808; nitrogen, 6·407; total phosphoric acid, 17·185; of this quantity, 6·188 is readily soluble, and 10·995 described as difficultly soluble; sulphate of potassa, 8·456.

Note-Paper which Contains Arsenic.—Dr. H. Vohl.—The author calls attention to the fact that there is now in the trade, at least on the Continent, a kind of beautifully light and deep rose-coloured note-paper, which, on being exposed to sunlight, is readily bleached, and, on being further investigated by the author, was found to be coloured with the arsenical residues of the fuchsine manufacture, and to yield, when treated with Marsh's apparatus, a considerable arsenical deposit.

Results of the Application of Various Kinds of Manure to Beet-Roots.—Dr. O. Tech.—This paper contains, in tabulated form, the results obtained on the large scale by the use of various kinds (23 in all) of manures, as applied to beet-roots in Bohemia.

Beet-Root Sugar Industry in Europe.—Dr. Dingler.—At the end of last year, there existed in Europe 1507 beet-root sugar works, of which 483 belong to France, 310 to the German Confederation, 283 to Russia, 228 to Austro-Hungary, 153 to Belgium, 42 to Poland, 20 to the Netherlands, 4 to Sweden, and 1 each to Italy and the United Kingdom of Great Britain and Ireland.

First number for July, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Stoddart's Suggestion Concerning the Concentration of Sulphuric Acid by Blowing Air through the Fluid while Hot.—F. Bode.—Inserted *in extenso*.

Application of Sodium as an Explosive Agent.—F. Springmühl.—The contents of this paper, illustrated with several woodcuts, describe a series of experiments made with the view to ascertain how far, and under what conditions, sodium may be applied as a substance suited to cause, by contact either with water or other materials, the explosion of vessels wherein these substances are contained. The force exerted is by no means small, as may be inferred from the following:—46 grms. of sodium and 18 grms. of water yield 2 grms. of hydrogen, a bulk of 22471·9 cubic centimetres. The space required for the sodium only amounts to 44·7 c.c. (the water is contained, previous to its coming into contact with the sodium, in a small bulb, which is solidly fixed by means of a neck to the bulb wherein the sodium is contained, which latter may be made of 50 c.c. capacity), taking 50 c.c. for the capacity of the explosion bulb, the pressure of the gas generated inside will be 450 atmospheres, equal to 6800 lbs. to the square inch.

Preparation and Use of Manganates and Permanganates of Alkalies.—E. Desclabissac.—This paper contains a description of the best and most practical methods suited for the manufacture of the salts alluded to, on the large scale.

Sulphuret of Cadmium (So-Called Cadmium Yellow), as a Pigment for Imparting a Yellow Colour to Toilet Soaps.—E. Schering.—The author, a manufacturing chemist, at Berlin, states that the pigment alluded to has been found to be the most durable and least expensive to impart to toilet soaps a fine yellow hue. The sulphuret is first rubbed up with some oil, and this mixture well incorporated by stirring with hot and liquid soap mass; the pigment does not dissolve therein, but is only finely divided. Two varieties of the cadmium yellow are now prepared on the large scale, one having a lemon, the other an orange-yellow colour.

Composition of Argol.—J. C. Sticht.—The author gives, in a tabulated form, the results of the analysis of 15 different samples, obtained from various wine-growing countries, of argol (crude bi-tartrate of potassa). The quantity of the salt was found to vary, in these samples, from 90 per cent to 34 per cent, while the quantity of tartrate of lime present in these samples varied from 52 per cent to 4 per cent.

NOTES AND QUERIES.

Distillation of Wood.—J. H. Mayor will find all the required information in a work entitled "Die Trockene Destillation der Holzes and die Verarbeitung der Durch Diesebbe Erhaltenen Roh Producti," von Dr. Ed. Assmuss (Berlin: 67, Verlag von T. Springa).—V. C.

Distillation of Wood.—(Reply to J. H. Mayor.)—We do not know of any book specially treating on this subject, but useful information will be found in vol. xviii. of the Chemical News, pages 91, 105, 132, and 168. You can also refer to vol. i., part 1, p. 340 and following, of the "Chemical Technology" of Richardson and Ronalds.

Schio Liao.—I have read an account lately of a cement used in China called *schio liao*, which is composed of 3 parts of blood and 4 parts of slaked lime, the blood to be beaten to deprive it of fibrine. Will you kindly say what is the meaning of destroying the fibrine, and in what way I am to proceed?—E. J. L.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 613.

NOTE ON THE

ACTION OF ALDEHYDE ON THE TWO PRIMARY UREAS.*

By Dr. J. EMERSON REYNOLDS.

THE action of the dicarbon aldehyde of the fatty series, C_2H_4O, on certain derivatives of ammonia, has of late been studied with considerable care, and most interesting results arrived at in the course of the investigation. We have been long familiar with the reactions of aldehyde with aniline, described by Schiff, who has shown that the dyad group C_2H_4'', or ethyliden, as it is often called, can replace successively two distinct proportions of hydrogen in the double molecule of aniline, water being eliminated according to the equations:—

1. $2(C_6H_5,NH_2)+C_2H_4''O=\left\{\begin{matrix}C_6H_5,NC_2H_4\\C_6H_5,NH_2\end{matrix}\right\}+H_2O.$

2. $2(C_6H_5,NH_2)+2(C_2H_4''O)=\left\{\begin{matrix}C_6H_5NC_2H_4''\\C_6H_5NC_2H_4''\end{matrix}\right\}+2H_2O.$

We are also acquainted with analogous reactions which have been obtained with amides and aldehydes of the aromatic series; it therefore appeared to be a matter of some interest to examine the action of aldehyde on another class of ammonia derivatives. I refer to the group of so-called *ureas*. Of these, there are at least two primary bodies,—one the well-known product of the animal organism, or Wöhler's beautiful artificial urea; and the other, the sulpho-urea which I discovered a few years ago.

It is unnecessary now to discuss the question of the identity or otherwise of Wöhler's and the normal urea. It is sufficient here to mention that all my experiments have been made on Wöhler's urea and on the analogous sulphur compound.

It will be convenient for the present to regard the two ureas just referred to as ammonia derivatives respectively of carbonic (according to Dr. Kolbe, carbamic), and sulpho-carbonic acids. Thus—

Wöhler's urea .. .. .. $CO''\left\{\begin{matrix}NH_2.\\NH_2.\end{matrix}\right.$

Sulpho-urea .. .. .. $CS''\left\{\begin{matrix}NH_2.\\NH_2.\end{matrix}\right.$

My object being to attempt the partial or complete replacement of hydrogen in each urea by the ethyliden group, according to the equation

$$CS\left\{\begin{matrix}NH_2\\NH_2\end{matrix}\right\}+C_2H_4''O=CS\left\{\begin{matrix}NC_2H_4''\\NH_2\end{matrix}\right\}+H_2O.$$

I may now be allowed very briefly to state the chief results arrived at in the course of the inquiry.

Action of Aldehyde on the Sulpho-Urea.

The first experiments were made with the sulpho-urea. A quantity of the pure compound was dissolved to saturation in nearly anhydrous aldehyde. The hot saturated solution was digested in a hermetically sealed flask, at a temperature of 100° C., for two hours. The solution was then allowed to cool. No urea crystals were deposited. After two days' standing, however, a number of minute, spherical, sub-crystalline masses were found to have attached themselves to the sides of the flask, and these gradually increased in quantity, until a considerable amount had been obtained. The clear liquid gave a copious white precipitate with water and with alcohol. The deposited body was carefully washed with cold alcohol, in which it is very slightly soluble, and then purified by solution in a large volume of boiling anhydrous alcohol, from which the new body separates out to a large extent on cooling a somewhat starch-like granular substance, seen under the microscope to be made up of extremely minute crystals. The analysis of the body gave numbers agreeing well with the formula:—

$$CS''\left\{\begin{matrix}NC_2H_4''\\NH_2\end{matrix}\right.$$

and is, therefore, derived from the urea by the replacement of half the hydrogen by ethyliden.

The new body is but slightly soluble in ether, rather more so in cold alcohol, but its solubility in boiling alcohol is much greater. In consequence of its relations to these solvents, the substance can be easily purified. It is but very slightly, if at all, truly soluble in cold water; but when digested at 100° C. with water, solution is obtained,—but solution in consequence of decomposition,—aldehyde being produced, and the urea separated with some ammonium sulphocyanate. The essential reaction is probably correctly represented by the equation—

$$CS''\left\{\begin{matrix}NC_2H_4\\NH_2\end{matrix}\right\}+H_2O=CS''\left\{\begin{matrix}NH_2\\NH_2\end{matrix}\right\}+C_2H_4''O.$$

or the converse of that, according to which the *ethylidensulpho-urea* is formed, dilute acids and alkalies act in the same way.

From the alcoholic solution I have obtained a platinum salt and a gold compound.

Action of Aldehyde on Wöhler's Urea.

The urea was dissolved nearly to saturation in aldehyde, and the solution digested in a sealed flask for two hours at 100° C. When cool, the flask was opened, and the contents poured into a suitable vessel, and the aldehyde slowly evaporated. No crystals of the urea were deposited, but a transparent pasty mass remained when the solvent had been almost wholly driven off. After standing for twenty-four hours, the residue was found to be white and friable. The mass was powdered, and digested in the cold with weakly-anhydrous alcohol, in which it is very slightly soluble at ordinary temperature, washed with the same liquid, and then boiled with alcohol. The filtered solution so obtained deposits, on rapid cooling, a considerable quantity of a flocculent body, seen under the microscope to be wholly made up of minute and considerably modified monoclinic crystals. Analysis gave the formula:—

$$CO''\left\{\begin{matrix}NC_2H_4''\\NH_2\end{matrix}\right.$$

for this body. A platinum compound has been obtained, but no gold salt.

The new substance is easily decomposed by digestion with water into aldehyde, and the products of decomposition of the urea. The first stage of the reaction, may, no doubt, be represented by the equation:—

$$CO\left\{\begin{matrix}NC_2H_4''\\NH_2\end{matrix}\right\}+H_2O=CO\left\{\begin{matrix}NH_2\\NH_2\end{matrix}\right\}+C_2H_4''O.$$

Having succeeded in replacing half the hydrogen in each of these ureas, directly, and by a very simple reaction, I endeavoured to go a step farther, and substitute a hydrocarbon group for the residual hydrogen within the molecule. All attempts in this direction have hitherto been fruitless.

In view of the facts above-stated and others well known, proving that half the hydrogen only is capable of replacement, and that each atom of nitrogen within the molecule of the urea is somewhat differently engaged, we are clearly warranted in slightly modifying the rational formula of each urea, in order to bring it into more complete harmony with the facts. The extent of the alteration is apparent,

* Read before the British Association, Edinburgh Meeting, Section B.

when we write the formulæ of the ethyliden-ureas referred to in this note, thus:—

$$\text{Ethyliden-urea}\left\{\begin{matrix}NC_2H_4\\COH\\NH.\end{matrix}\right.$$

$$\text{Ethyliden-sulpho-urea}\left\{\begin{matrix}NC_2H_4\\CSH\\NH.\end{matrix}\right.$$

ON THE CONSTITUTION OF SALTS.*

By J. ALFRED WANKLYN,
Corresponding Member of the Royal Bavarian Academy of Sciences.

Some time ago I made the observation that there existed a numerous class of chemical compounds isomeric with the soda-salts of the fatty acids, but radically different from them in constitution. The compound obtained by the action of acetic ether on ethylate of soda belongs to this class. Its composition is expressed by the empirical formula $C_4H_7NaO_2$, being an isomer of butyrate of soda; but instead of yielding butyric acid when treated with dilute sulphuric acid, it gives alcohol and acetic acid, showing that its four atoms of carbon are not bound together in one group. At first sight two theories of the structure of this singular compound present themselves. It might be acetate of sodinated-ethyl or sod-acetate of ethyl—

$$\left.\begin{matrix}C_2H_3O\\C_2H_4Na\end{matrix}\right\}O \quad \text{or} \quad \left.\begin{matrix}C_2H_2NaO\\C_2H_5\end{matrix}\right\}O$$

But the action of iodide of ethyl on it demonstrates that it is neither the one nor the other. Treated with iodide of ethyl it gives neither acetate of butyl nor butyrate of ethyl. Instead of yielding either of these products it breaks up into alcohol, isocaproate of acetylinated ethyl, and iodide of sodium, thus:—

$$2C_4H_7NaO_2+2C_2H_5I=Na_2I_2+C_2H_6O+C_{10}H_{18}O_3.$$

The mechanism of this reaction I have explained on former occasions. The fact to which I wish to call particular attention is, that herein we have an example of ethyl being *substituted* for sodium, without *true replacement* being effected. It is a critical instance showing that monatomic ethyl does not discharge the function of the metal sodium. As those who are familiar with my work will recollect, I assign to the isomer of butyrate of soda the rational formula—

$$Na'''\left\{\begin{matrix}OC_2H_4\\C_2H_3O\end{matrix}\right.$$

and the name acetate of ethylene-sodium.

Reasoning from this sodium compound and from the multitude of double sodium-salts which are known to exist, I have been led to assign a triatomic function to the metal sodium, and formulate such compounds as caustic soda and acetate of soda as follows:—

$$Na'''\left\{\begin{matrix}O''\\H\end{matrix}\right. \text{(Caustic soda).}$$

$$Na'''\left\{\begin{matrix}O''\\C_2H_3O\end{matrix}\right. \text{(Acetate of soda).}$$

Should these views prevail (and the more I enquire into the subject the more disposed I become towards them), most of the common formulæ of metallic compounds will be altered. The water-type, which is at the present moment employed to represent metallic salts, will, in many instances, have to give way to the ammonia-type; and so the metallic salt and the corresponding acid will be represented by chemical formulæ radically dissimilar.

One of the consequences of the new theory being, thus, that metallic salts and acids are radically unlike, it derives support from experimental differences between salts and their corresponding acids.

The salts of alumina are usually regarded as approximating most closely to the "so-called salts of hydrogen." The recognition of fundamental differences between salts of alumina and acids is, therefore, specially to the point. I have recently observed two such differences. Nitrate of alumina, unlike the so-called nitrate of hydrogen, does not dissolve chromate of silver. A mixture of nitrate of alumina with hydrochlorate of alumina in aqueous solution admits of being boiled without evolving chlorine.

These experimental facts exhibit striking difference between the salt and the acid. They also show that salts of alumina are not so prone to decomposition as is commonly believed.

* Read before the British Association, Edinburgh Meeting, Section B.

ON THE EFFECTS OF HEAT ON PROTOPLASMIC LIFE, PREVIOUSLY DRIED.

By F. CRACE CALVERT, F.R.S., &c.

The following series of experiments was instituted as a sequel to those already published, and with the view of ascertaining whether animalculæ which had been previously dried would resist a higher temperature without being destroyed than animalculæ when heated *with* the fluid in which they were living.

In hope of throwing some light on this point, small thin slips of glass, 3 centimetres in length and 5 m.m. in breadth, were taken, and one side of each slip was smeared with a thin coating of putrid albumen containing a considerable quantity of microscopic life.

Fifty-six of these slips of glass were prepared on the 5th of July, 1871, and allowed to dry in the air for twenty-four hours, when twenty-eight of them were taken and sealed in tubes of the same size as those used in the experiments already published, whilst the remaining twenty-eight were placed in an air-bath, and kept at a temperature ranging between 100° and 120° F. for fourteen hours, and than sealed in tubes.

Therefore there are two series of experiments—one in which the putrid fluid was merely dried on the slips at natural temperature; the other in which the fluid, after being dried in the air, was thoroughly desiccated in the bath.

Four from each series were set apart and not heated; the remaining tubes of both of the series were rolled in wire gauze to prevent, as far as possible, any danger arising from the accidental bursting of any of the tubes, and placed in an oil-bath, which was gradually heated and kept for half an hour at the following temperatures:—100°, 200°, 300°, 400°, 500°, and 600° F. Four tubes from each series were taken out at each temperature, and those that remained were kept in the bath with its temperature at another fixed point for half an hour.

The above experiments gave rise to three series of experiments:—

First.—Some of the glass tubes were broken; the small slips of glass they contained were taken out and laid on a microscopical slide, which had previously been moistened by a drop of pure distilled water, left for about fifteen minutes, and then examined.—July 8.

Second.—Other slips were taken from each of the series and placed in small tubes, 5 centimetres in length and 8 m.m. internal diameter, with equal quantities of pure distilled water, and then hermetically sealed.

These slips were heated on the 11th of July, and examined on the 15th.

Third.—Slips were placed in tubes, 7 centimetres in length and 15 m.m. in diameter. The tubes were then filled with a solution of albumen which had been prepared on the 22nd of April last, and was still absolutely free from life, having been prepared by the process described in my first paper.

This series was commenced on the 11th and examined on the 15th of July.

Series I.—Slips (*dried in air*) and simply heated at the various temperatures. Moistened with water on the slide of the microscope, and examined immediately.

Not heated.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400 F.	Heated to 500° F.	Heated to 600° F.
1. Six or seven living animalculæ were present under each field. None were swimming, but all were moving to and fro with distinct vital motions. The majority are ordinary vibrios; a few of them, however, are long vibrios.	2. Life is present to about the same extent, and with about the same vitality, as exists in 1.	3. Same class of vibrios exist here as in 1 and 2, and to about the same extent and with the same amount of vitality. So that up to this point there appears to be little or no difference in the amount of life.	4. There is a very decided decrease in the amount of life here. All the long and nearly all the ordinary vibrios have been destroyed. Two or three small vibrios are still present, however, moving to and fro under each field.	5. No life present.	6. No life present. The albumen on the glass-slip has been charred, and pieces of this charred mass appear under the microscope to resemble shellac.	7. No life present. The albumen on the slip is charred to a greater extent than 6, and small carbonised pieces, mixed with the shellac ones, were present.

Series II.—Slips (*dried in bath for fourteen hours between* 100° *and* 120° *F.*) were simply heated at the various temperatures. Moistened with water on the slide of the microscope, and examined immediately afterwards.

Dried in bath, but not heated after.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1. There are seven or eight animalculæ under each field. They are principally ordinary vibrios, and there were also a few long and very long vibrios present.	2. Exactly the same class of life is present here as in 1. It exists to the same extent, and with the same amount of vitality.	3. There is no difference in the life present here to that existing in 1 or 2.	4. There is a very decided decrease in the amount of life present here to that observed in 1, 2, or 3. All the ordinary, long, and very long vibrios have been destroyed, and only a few small black vibrios are left, which are sufficiently distinct in their appearance and motion to show that they are still alive.	5. All the life has been destroyed.	6. No life present.	7. No life present.

Series III.—Slips (*dried in the air*), and afterwards heated to the different temperatures, were introduced into small tubes containing pure distilled water on the 11th of July, hermetically sealed, and on the 15th of July the water in each of the tubes was examined.

Water alone for comparison.	Not heated at all.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1. No animalculæ life present.	2. Four or five ordinary vibrios are present in the whole drop, two of which are swimming about.	3. About forty *bacteria* vibrios are sprinkled about under each of the bottom fields, and about ten or twelve long and ordinary vibrios are swimming about throughout the drop.	4. One or two large or ordinary vibrio is observed under most of the field moving to and fro.	5. A few energetically-moving dots and small vibrios are present throughout the whole drop. No *bacteria*.	6. No trace of animalculæ life is present, but a number of pieces of matter are oscillating to and fro.	7. No animalculæ life present.	8. No animalculæ life present.

Series IV.—Slips (*dried in bath at* 100° *and* 120° *F.*), afterwards heated to the different temperatures, and the slips then taken from their original tubes and introduced into tubes containing pure distilled water on the 11th of July, and examined on the 15th.

Merely dried in bath, not heated.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.
About one ordinary vibrio was observed moving to and fro under each field.	The appearance of the fluid here is exactly the same as 1.	About seven or eight *bacteria* vibrios are present under each field, and one ordinary swimming vibrio is present under most of the fields.	About one or two ordinary swimming vibrios were observed throughout the whole drop.	No animalculæ life present.	No animalculæ life present.	No animalculæ life present.

Series V.—Slips (*dried in air*), afterwards heated to the different temperatures, were then introduced into tubes containing equal quantities of an albumen solution. They were hermetically sealed on the 11th of July, and examined on the 15th.

Albumen alone for comparison.	Not heated at all.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.	8.
No distinct vibrio life is present.	Four or five distinct vibrios were observed moving to and fro throughout each drop. No *bacteria* vibrios were observed.	Four or five *bacteria* vibrios were present at the bottom of each field, and one or two ordinary or long vibrios were swimming about above them.	About one ordinary vibrio moving to and fro under most of the fields, and one or two *bacteria* vibrios were observed throughout the drop; but no swimming life is present.	A few *bacteria* vibrios were present throughout the drop, and a very few were moving to and fro.	No life.	No life.	No life.

Series VI.—Slips (*dried in bath between the temperature of* 100° *and* 120° *F.*) heated to the different temperatures, and introduced into the tubes containing albumen solution, and sealed on the 11th of July and examined on the 15th.

Albumen alone for comparison.	Not heated at all.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.	8.
No distinct vibrio life present.	About ten or twelve ordinary *bacteria* vibrios are present at the bottom of each field, and twelve or fourteen ordinary and rather long vibrios are swimming. There is also a number of some fungi present, which gives the fluid a turbid appearance when shaken up.	There is about the same amount of life here, and the fluid has much the same appearance as 2.	There is life present here, but not to such an extent as it exists in either 2 or 3.	A few *bacteria* vibrios are present at the bottom part of each field, and one or two ordinary vibrios and microzymes are swimming about above them.	No life.	No life.	No life.

ON THE USES OF A NEW PRECIPITATING REAGENT OF COPPER.

By HUGO TAMM.

In the current work of analytical chemistry the use of apparatus is to be avoided on nearly every ground; and, on the contrary, reagents ought to be employed whenever this can be done with safety. But a reagent, to be perfect, must fulfil certain conditions.

(1). When employed for the determination of a solid substance it should be volatile, or, if it is fixed, it should not form, with the precipitate, compounds of indefinite composition.

(2). It should form, with the element to be determined, a compound as insoluble as possible.

(3). It should not introduce in the liquid separated from the precipitate any substance likely to alter the behaviour of its constituents, with general or respective reagents, and, least of all, it should not introduce any substance difficult of separation from any of the constituents.

(4). It should separate the element to be determined, in the shape of a compact precipitate, in neutral or acid liquors, and allow the other elements of the combination to remain in solution.

This is, perhaps, the most important principle in analytical chemistry.

The reagent which I now propose fulfils these conditions, and is, consequently, very perfect; in practice it will be found very useful. It is obtained by dissolving in distilled water equal weights of sulphocyanide of ammonium and of bisulphite of ammonia. This mixture keeps well, and can be used several months after its preparation, providing it is not left exposed to the air for any length of time; but, should a slight alteration take place in its composition, this would be of no consequence.

A mixture of equal weights of sulphocyanide of potassium and of bisulphite of potash or of soda answers equally well; in fact, it keeps still better than the former mixture, and the only objection to its use is its being composed of fixed salts.

Either of the five salts above mentioned can be obtained in a great state of purity, and, as both mixtures are equally perfect as regards the estimation of copper, I should recommend the first for analytical purposes and the second for simple assays of copper.

The important property of this reagent consists in forming, in solutions of copper acidulated with hydrochloric acid, an abundant white precipitate of subsulphocyanide of copper, which is completely insoluble.

The only precaution to take to ascertain the presence of copper in a solution is to neutralise any nitric acid which might be present with an excess of ammonia, and then to acidulate the solution with a slight excess of hydrochloric acid.

The behaviour of this reagent is easily explained. Bisulphite of ammonia, which, in ordinary circumstances, reduces but very slowly proto-salts of copper, reduces them instantaneously, in presence of sulphocyanide of ammonium, and this salt forms immediately with the subsalt of copper produced the subsulphocyanide of copper, which is precipitated, and thus the behaviour or the mixture is that of an ordinary simple reagent.

The qualitative uses of this reagent are somewhat limited; still it is most useful to ascertain at once beyond a doubt that a blue ammoniacal liquor owes its colour to copper. For this purpose the ammoniacal liquor is supersaturated with hydrochloric acid, a few drops of the reagent are added, and, if copper is present, it is immediately precipitated. If, on the contrary, the blue colour is due to nickel or iridium, no precipitation takes place, but if the colour is partly due to copper and partly to some other metal, then a separation takes place, copper is precipitated, and the filtrated liquor, saturated anew with ammonia, assumes a blue tinge.

It is needless to say that if, through neglect or through some unexpected reaction, a white precipitate were obtained with the reagent, and if some doubt existed as to its containing copper, it would only be necessary to oxidise and dissolve the precipitate in nitric acid, and saturate the solution with ammonia in excess to obtain—copper being present—the characteristic blue liquor. Or the white precipitate may be dissolved at once in ammonia. In presence of the air it oxidises rapidly, and soon imparts to ammonia the blue colour due to copper.

When the white precipitate of subsulphocyanide of copper is thoroughly washed—and this is the case, not as might be presumed when the washings are free from sulphocyanides as detected by perchloride of iron, but, on the contrary, when they are free from chlorides which adhere more strongly to the precipitate than sulphocyanides—and when the precipitate is thoroughly dried, its formula is Cu_2CyS_2, and it contains 52·30 per cent of copper.

As in chloride solutions the only metal precipitated by the reagent is copper, it affords easy means of separating this metal from all others, and of estimating it with promptitude, and with the greatest accuracy. In analytical researches and in quantitative determinations it is an invaluable reagent.

In the few examples which follow will be found the way of proceeding and the precautions to take to effect the separation and determination of copper, in the chief products containing this metal.

Estimation of Copper in Pure Copper and in Swedish and Russian Copper.

Twenty grains of the metal are dissolved in nitric acid. The solution, diluted with water, is supersaturated by ammonia, and a sufficient quantity of hydrochloric acid is added to make the blue colour disappear and to give a greenish solution quite clear. The liquor, which is very warm, is allowed to cool to a temperature of about 50° C., and enough water is added to make it occupy from ½ to ¾ of a pint. The reagent is then added little by little. At first a dark brown liquor is obtained which rapidly turns to a white precipitate* which settles rapidly. When the precipitation is complete, a few drops of the reagent are added in excess; the whole is allowed to rest in a warm place for some little time. The precipitate is collected on a double filter, and washed until no chlorine can be detected in the washings by means of nitrate of silver. It is then thoroughly dried, and afterwards weighed, and the quantity of copper is calculated from the composition of the precipitate given above. The drying of the precipitate being the longest part of the operation, whenever it is required to make a rapid determination the process can be modified as follows:—

The washed sulphocyanide of copper is detached while wet from the filter; the filter is burnt, and its ashes are mixed with the precipitate, which is digested for some time with an excess of sulphide of ammonium. By this means sulphuret of copper is obtained. It is filtered and thoroughly washed; it is then dried very rapidly in a small porcelain crucible, and calcined. This being done, a little excess of pure flour of sulphur is thrown in the crucible, which is then carefully covered, and all the sulphur is driven off at a low red heat. After cooling the residue of sulphuret of copper presents the constant formula Cu_2S, and it contains exactly ⅘ of its weight of copper.

Estimation of Copper in Bar Copper, and in Native Copper.

The complete analysis of this metal is very delicate, and it can safely be assumed that no analysis of it, previous to the use of sulphocyanides, was ever very perfect, or very reliable. On the contrary, by using the reagent every

* If the dark colour persisted, and if nitrous fumes were evolved the solution should be rejected at once as unfit for use. This happens when nitric acid has not been properly saturated.

trace of foreign metals can be easily detected and determined after the separation of copper is effected.

Twenty grains of the metal are dissolved in nitric acid, and, if the solution is quite clear, the copper is estimated exactly as in the former example. If, on the contrary, a precipitate of oxides of antimony or tin is manifest in the liquor, it should be dissolved by adding a little hydrochloric acid, or a fresh lot of metal should be dissolved in aqua regia. This being done, the determination of copper is proceeded with exactly as previously stated.

For the complete analysis, 100 grs. are dissolved in nitric acid or in aqua regia. The solution, supersaturated with ammonia, is re-acidulated with a slight excess of hydrochloric acid, and the liquid is made to occupy at least one pint. The reagent is then added, with the precaution already indicated, and in general, when the precipitation is complete, the supernatant liquid assumes a pink or red colour due to sulphocyanide of iron. The liquid is then filtered on a double filter (this precaution is useful because the sulphocyanide of copper is apt to pass through single filters), and the precipitate is well washed. The liquid, mixed with a little more hydrochloric acid, is boiled until no smell of sulphurous acid from the reagent can be detected; it is then submitted to analysis.

Lead, arsenic, and antimony will generally be found. Even coppers leaving no residue in nitric acid contain antimony which can be detected and estimated when separated in this way. The same remark applies to tin, which exists more often than might be supposed. Bismuth, nickel, and zinc are three metals which exist very frequently, also, in copper. Cobalt is found pretty often too, and silver and iron are nearly always present.

Sulphur, which exists frequently, must be determined in a special operation.

The usual method of analysing copper, by precipitating it with sulphuretted hydrogen, and by treating the precipitate with sulphide of ammonium, is most imperfect. The bulky precipitate of sulphide of copper holds the small quantities of sulphurets of antimony, arsenic, and tin, with an adhesive power nearly equal to the dissolving power of ammonia. If the dissolving power of this reagent is increased by addition of sulphur, a large proportion of copper is dissolved, and the analysis is complicated and inaccurate. Furthermore, the separation of the small quantities of the other metals precipitated with the copper is also difficult and imperfect by ordinary processes.

Estimation of Copper in Brass, in Bronze, and in German Silver.

The separation of copper in alloys containing considerable quantities of zinc presents great uncertainty when effected by means of sulphuretted hydrogen. This is due to the capricious behaviour of the zinc in presence of sulpuret of copper, and this process ought to be rejected without hesitation, the more so that the reagent answers admirably the purpose, and that the separation effected by its means is one of the neatest in analytical chemistry.

Quantities of the alloys, varying from 20 to 50 grs., should be dissolved for the determination of their chief constituents, and no less than 100 grs. should be employed for the determination of the smaller quantities of foreign metals. The proceedings are identical with those indicated in former examples.

In bronzes, tin can be separated by nitric acid. This mode of separation is sufficiently accurate for ordinary purposes, but in correct analyses it would be advisable to dissolve the alloy in aqua regia, and proceed first to the separation of copper.

With these alloys the copper reagent proves invaluable, not only as affording means of estimating with facility and accuracy the composition of important alloys, but also as enabling the chemist to determine the very important question of the cause or causes of brittleness in those alloys.

Estimation of Copper in Pyrites, in Copper Ores Generally, and in Slags.

The reagent proves much less useful and necessary in the analyses of these minerals and slags than in those of the former products, for the reason that ordinary methods answer well when applied to them. Indeed, it is not advisable to use the reagent at first to effect the separation of copper, unless this metal exists in large quantity, and is alone to be determined. However, if uniformity in the estimation of copper was an object, no objections would be raised against using the reagents which separate the copper with equal perfection whatever substances accompany it. But for analytical purposes it would be best to precipitate by sulphuretted hydrogen, copper, and the group of metals which are precipitated with it, and thus to separate them from the large proportions of iron and of earthy matters which may be present.

The precipitated sulphurets being re-dissolved in nitric acid or in aqua regia, this solution can be submitted to analysis, and, in most cases the reagent can be employed with advantage in this part of the operation, and if copper is the most abundant metal of all, it will prove as useful as ever. If, on the contrary, copper formed only a small fraction it would be best not to use the reagent at all, but to apply the ordinary methods of separation.

Some pyrites and certain earthy minerals contain about equal proportions of bismuth and copper. In these instances it is best to separate bismuth first, to avoid all possibility of this metal being precipitated by water and mixed up with copper. The same remark applies to cases where antimony is present in large proportions.

As a general rule, when a metal, such as lead, silver, antimony, or bismuth, exists in large proportions, and when this metal can be easily separated from copper, it is best and safest to effect its separation at once.

There are instances in which the separation of copper is not only difficult but imperfect with ordinary methods. Such is the case when copper exists in a liquor with palladium, vanadium, molybdenum, and cadmium. In these instances no better means of separation can be resorted to than to use the reagent, which effects all these separations as, indeed, most separations with the greatest perfection.

THE VERTICAL LANTERN; A NEW INSTRUMENT OF DEMONSTRATION.

By HENRY MORTON, Ph.D.,
President of the Stevens Institute of Technology.

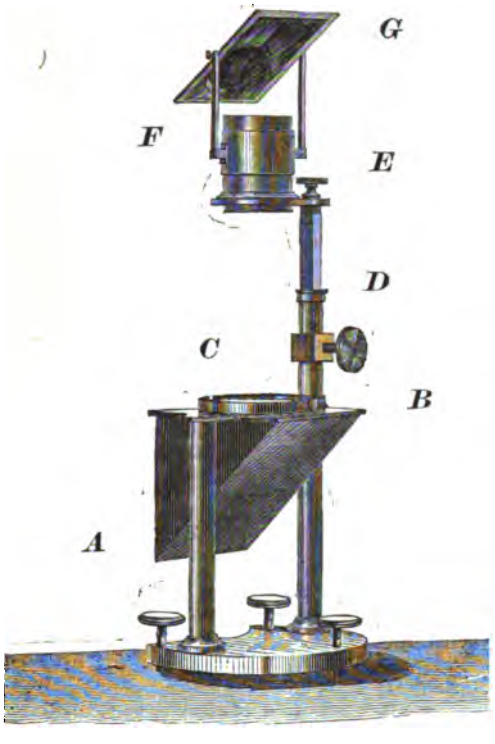
During a visit to Cambridge, Mass., last summer, Prof. J. P. Cooke was kind enough to show me an arrangement, which he had been using for several years, for the projection, on a vertical screen, of objects, such as "cohesion figures," which require to be kept in a horizontal position.

To effect this result a square box, containing a diagonal mirror, was attached to the front of a large lantern, so that the rays proceeding from the condensers were thrown vertically upon the object, such as a tank of water, placed above. Over this, again, was supported the object-glass, and a mirror, silvered on its front surface, by which the image was thrown on the screen. Among the objects which were then shown, I was particularly impressed with a tank of water, in which waves being made by falling drops gave a beautiful pattern of interfering lines and curves in delicate grey tints upon the screen.

The only defect in the action of this instrument was the want of an equal illumination in the field, resulting from the separation of the object from the front of the condenser.

I was so favourably impressed with the apparatus, however, that at the earliest opportunity I prepared a design, and had the instrument represented in the accompanying cut constructed by Messrs. Hawkins and Wale, apparatus makers to the Stevens Institute.

Its arrangement was as follows:—The lantern condenser in the first place was made of three lenses, the first two of such curve as to give with the light, at about two inches from the nearer one, a practically parallel beam, which was received upon a mirror, A B, at 45°, and, after reflection from it, fell upon the third lens placed horizontally at C, which concentrated it on the objective at E, from which it passed to the mirror, F G, which, in turn, threw it on the screen. This mirror, moreover, was not silvered on the exterior surface, but in the usual way, though with pure silver, on the back, and yet no want of definition was to be perceived in the image, owing, no doubt, to the fact that the faint reflection from the first surface was inappreciable in comparison with that from the metallic silver. In several articles published in the CHEMICAL NEWS and elsewhere, a square prism has been described as being used for the same purpose, but a little thought, or, still better, a moment's experiment, would show that this means would not answer, because about one-third of the cone of rays entering the prism would be at too great an



angle for total reflection, and would thus leave one-third of the field dark.

In producing waves in a tank of water, I have used with great satisfaction a little apparatus devised by Messrs. Hawkins and Wale, consisting of a metallic box with a sheet rubber cover, provided with a long thin metal tube; this was so placed that the tube was about one-quarter of an inch above the point in the tank which it was desired to make the centre of the wave motion. On tapping the rubber diaphragm, a momentary puff of air was driven from the tube, producing exactly the disturbance needed. An elliptical ring being placed in the tank, the properties of that curve with regard to reflection are very neatly exhibited, and, in fact, independent of their scientific interest, nothing could be more charming than the pearl-grey waves, crossing and interlocking and combining in complex patterns, which raced across the screen.

"Cohesion figures," "magnetic spectra," and the metallic vegetation developed by an electric current in a solution of chloride of tin, are among the illustrations specially suited to this instrument, and I have lately added another, by so supporting a large glass Chladni plate as to bring one of its corners over the condensers, covering this with a thin layer of water, kept in place by a thin ring of rubber cemented to the glass, and exciting the plate with a violin bow. The entire screen is then covered with a beautiful pattern of crispations, varying with the sounds obtained by variously damping the plate. This experiment I used with great satisfaction at a lecture lately delivered in the Academy of Music in Philadelphia, a building which seats over 3000 persons. This will afford some idea of the efficiency of the apparatus; I have, in fact, been greatly surprised by the amount of light which reaches the screen from this apparatus, which is far in excess of what I anticipated when considering the two reflections and other causes of loss.

ON RECENT INVESTIGATIONS AND APPLICATIONS OF EXPLOSIVE AGENTS.*

By F. A. ABEL, F.R.S., Treas. C.S.

IN submitting to the Members of the British Association some account of recent progress made in the production and application of explosive agents, I cannot attempt to give much more than an outline of the nature and results of important investigations which have been instituted, and are still being pursued, relating to the development and regulation of the explosive force of gunpowder, and to the application of some other explosive materials, which are already supplanting gunpowder in several of its important uses.

The manufacture of gunpowder required for war purposes was carried on here and abroad for very many years without any important modification. The system pursued in this country in effecting the incorporation of the ingredients, and in converting the mixture into granulated gunpowder, of sufficient density and hardness to enable it to resist injury by transport and storage in all climates, furnished a product which was greatly superior to the generality of foreign gunpowders in regard to its keeping qualities, but which was also more violent in its action, because, in fact, the conditions essential to a rapid and complete transformation of the several constituents were more thoroughly fulfilled in its manufacture; and which hence earned on the Continent the name of *poudre brutale*.

The comparatively small charges used even with the heaviest cast-iron smooth-bore guns, which, until recently, constituted our most powerful armaments by sea and land, were, however, regarded in this country as not unduly trying to the endurance of those guns; and although, about fourteen years ago, some attention was directed to the question of modifying the form or proportions of heavy guns with a view to increase their durability, in consequence mainly of some very instructive experiments instituted in America by Major Rodman, it was not until some little time after the first great stride was made in the increase of power of our artillery (by the introduction of the 110-pounder Armstrong rifled wrought-iron gun), that attention became seriously directed to the importance of attempting to reduce the violence of action, or rapidity of explosion, of the gunpowder to be employed in the increased charges required to impart the requisite velocity and accuracy of flight to comparatively heavy projectiles.

A comparison of the weight of shot and of the charges of powder used in the heavy guns of the present day, with those employed in the most formidable *cast-iron* siege and naval guns, will at once show how greatly the conditions must have become modified which attend the application of gunpowder to projectile purposes. Much has been

* A Lecture delivered to the Members of the British Association at Edinburgh, August, 1871.

written and said, especially of late, as to our having been far behind other nations in devoting attention to the modification of gunpowder, with a view to meet the altered conditions attending its application in the heavy guns of the present day; but the fact is, that not only were the first investigations into the action of fired gunpowder made in this country, but steps were also taken in England, almost as soon as in any other country, towards the production of a gunpowder, by employment of which the full powers of heavy guns may be developed with the least detriment to their durability.

In 1858 a small committee was appointed to determine upon the best description of gunpowder to be used in the Enfield rifle, and not long afterwards this committee was instructed to extend its inquiry to cannon powder—the most powerful gun of the service at that time being the 110-pounder Armstrong gun. One of the members, General (then Captain) Boxer, had, some few months previously, called attention officially to the desirability of modifying the action of the charges of powder used in the larger natures of guns, either by employing a weaker powder, or a larger grain and denser powder, the charge being increased in amount in order to obtain the same average pressure, and, consequently the same initial velocity, as furnished by the quick powder then used. A careful consideration of the directions in which gunpowder was susceptible of modification, with a view to the reduction of the rapidity of its explosion, led the committee to institute a series of experiments, which resulted, in the first instance, in the introduction into the service, in 1860, of the so-called rifle large-grain powder for all rifled guns, and subsequently in the provisional introduction of pellet-powder for the heavier natures of ordnance. The means and appliances at the command of this committee for carrying out their experimental investigations were small and imperfect: but the results at which they arrived not only served as the starting-points of the successful results attained by the present Committee on Explosive Substances, but also became known to and aroused the attention of Continental Powers, through the agency of officers who visited this country at about the time of the Exhibition of 1862, at which date pellet-powder had already been experimented with for some little time. In America experiments on gunpowder were vigorously pursued at the same time as they were being slowly carried on, with comparatively imperfect means, in England, and the particular form of powder known as prismatic, the production of which was developed in Russia a few years ago, and which has been to some extent adopted in Prussia, appears to have been of American origin, though it has not found favour in that country, where a gunpowder similar in form and size to the new powder known as *pebble* is employed in guns of large calibre, under the name of *mammoth powder*.

The principles laid down by the first Committee on Gunpowder, in 1858, as their guide in attempting to reduce the violence of action of powder when fired in large charges, have been, up to the present time, adhered to by those since entrusted with the continuance of these investigations. Before specifying them it may be instructive to glance briefly at some ways in which gunpowder may readily be modified, with the object of increasing or diminishing the rapidity and violence of its explosion, and at the reasons why they have not hitherto been selected.

As gunpowder is simply an intimate mechanical mixture of a powerful oxidising agent—saltpetre or potassium-nitrate, with two readily-oxidisable substances, sulphur and carbon or charcoal—it is obvious that the behaviour of this mixture, *i.e.*, the rapidity with which it will explode, and the nature of the results furnished by its explosion, are susceptible of great modification by variations in the proportions of its ingredients.

According to the long-accepted chemical theory of the action of gunpowder, the function of the charcoal was to undergo conversion into gas by partial or complete oxidisation (*i.e.*, by conversion into carbonic acid or carbonic oxide), according to the proportion which it bears to the saltpetre employed, while the sulphur was considered to act in two ways—firstly, in promoting the ready ignition of gunpowder by reason of its great inflammability; secondly, by uniting with the potassium in the saltpetre, and thus rendering available the whole of the oxygen for the oxidation of the carbon.

That this view is, to say the least, only a very imperfect explanation of the action of the ingredients in gunpowder, has long since been demonstrated; but the broad facts are undoubted that the rapidity of explosion of a mixture of these three substances may readily be increased or diminished by modifications of the proportions of sulphur or charcoal, or of both, with which the saltpetre is mixed. A very notable difference may be observed in the rate at which two trains will burn, which consist of gunpowders in other respects alike, but differing, for example, in the proportion of charcoal which they contain.

A comparison of the composition of English and foreign gunpowders shows that some of them differ considerably from each other as regards the proportions of their ingredients; and there can be no doubt that these differences may exert a very decided influence upon the action of these gunpowders.

The extent to which the charcoal employed in their preparation has been burned (*i.e.*, the duration of the carbonising process, or the temperature at which it has been effected), and its consequent composition, also vary considerably, and it has been abundantly demonstrated, by the more recent experiments conducted at Woolwich, that, the other characters of cannon powders, tried one against another, being alike, the violence of action increases in direct proportion to the amount of volatile constituents (as indicated by the proportions of hydrogen and oxygen) which have been allowed to remain in the charcoal. This result was observed many years ago in connection with powder for small arms, the French having found that a highly inflammable charcoal (*charbon roux*), produced by exposure of wood to a comparatively low temperature, furnished a very violent gunpowder, which, on account of its destructive action upon the firearm, was termed *poudre brisante*. It was, however, not known that apparently small differences in the composition, and consequently in the physical properties and ready inflammability of the charcoal might be productive of very considerable differences in the action of gunpowder even when employed in large charges.

It need scarcely be pointed out after what has been said regarding the influence exerted by certain variations of composition upon the rapidity of explosion and consequent violence of gunpowder, that different modifications in the composition of powder, which are opposed in the results they produce, may be made more or less completely to neutralise each others effects. Thus, the reduction in rapidity of action of gunpowder, which may be effected by a diminution in the proportion of the inflammable ingredient sulphur, or of the oxidising ingredient saltpetre, may be counteracted by the employment of a slackly-burned, and therefore highly inflammable, charcoal; and in this way it may be possible that the composition hitherto fixed for gunpowder in this and some other countries may be susceptible of modification, with advantage in point of economy.

Sufficient has been said on this head to show that the explosive action of gunpowder is susceptible of very extensive modification by variation of its composition. But inasmuch as the force exerted by gunpowder is due not simply to the actual amount of gaseous products resulting from the explosion, but also, and in the largest proportion, to the heat developed by the chemical action, it follows that there must be particular proportions of ingredients which, leaving other conditions out of consideration, would appear the best, as furnishing the largest amount of gaseous matter compatible with the development of the highest temperature.

There can be no doubt that the proportions of saltpetre,

sulphur, and carbon, fixed upon in the earlier days of gunpowder manufacture (and which have hitherto undergone no *very* considerable modification, and indeed *none* made with any definite design), were not fixed upon by any theoretical considerations, but were purely the result of tentative experiments; but they very nearly correspond to those required for the development of the most energetic action of the saltpetre upon the carbon (regarding the charcoal for a time as pure carbon), though they are not calculated to furnish the largest amount of gas from a given weight of the mixture. The latter result would necessitate the employment of the carbon in the proportion to produce carbon monoxide, or carbonic oxide; while the amount actually used in gunpowder is approximately that required to produce only carbon dioxide or carbonic acid, assuming the sulphur only to exercise the function above indicated, and not to take to itself any of the oxygen of the saltpetre. It has now been long established that the sulphur does at any rate undergo partial oxidation; but it is also admitted that the employment of the proportions of saltpetre, carbon, and sulphur, indicated by the old theory, which provided for the full oxidation, or conversion into carbonic acid, of the greater part of the carbon, furnished a mixture by the explosion of which a comparatively very great amount of chemical energy, and consequently of heat, is developed (or of pressure, when the charge is confined).

It is upon such considerations as these that the late Committee on Gunpowder came to the conclusion that, in attempting to moderate the explosive violence of gunpowder when used in large charges it was inadvisable to make any change in the established composition of gunpowder which might be productive of a diminution of the total pressure developed by a charge, unless the desired results were unattainable by modifying the mechanical and physical characters of powder—in other words, by introducing changes in the *preparation* of gunpowder, and in the *form* in which it is employed. It required but few experiments to demonstrate that the rapidity of explosion of gunpowder was readily susceptible of great reduction by simple mechanical means, and hence those means have been adhered to by the present Committee on Explosive Substances, in elaborating the powder now manufactured for naval and siege guns.

The degree of perfection to which the ingredients of powder are prepared by grinding, and afterwards mixing or incorporating, affords an obvious means of modifying the rapidity of explosion of the mixture, but it would also evidently be both unphilosophical and unpractical to reduce the rapidity of burning of powder by diminishing the degree of completeness to which the ingredients would react upon each other, and thus employing them wastefully, which would be the case if they were not converted into as intimate a mixture as is attainable by known means and appliances. But, starting with as perfect a mixture as can be prepared of the ingredients in the proportions calculated to furnish the maximum attainable change of volume (and consequently of total pressure at the time of explosion), there are *five* different directions in which gunpowder may be modified as regards its physical and mechanical characters, and the means thereby presented of regulating the rapidity of explosion, have, up to the present time, proved quite sufficient for all requirements. These variable points are—*the size* of individual masses composing the charge of powder; *the form* of these masses, and the *mechanical condition* of their *exterior*; the *density* or compactness of the masses, and their *hardness*. The size and form of the masses are readily modified by moulding the mealed powder into forms of a particular size and shape, as in the case of pellet-powder, prismatic, cubical, or spherical powder; or by breaking up, to a greater or less extent, and in a symmetrical or irregular manner, cakes of compressed powder of different thicknesses, thus producing what is called granulated powder, which ranges in size from fine sporting powder to pebble powder. The surfaces of these masses may be left in their original rough condition, or they be more or less smoothed and deprived of sharp angles and edges by means of attrition and subsequent glazing or coating with graphite; and their ready inflammability may be correspondingly reduced. The density or compactness of the powder is determined by the pressure to which the material is submitted when converted into slabs, pellets, or other forms; and the hardness is regulated by the proportion of moisture contained in the powder at the time that it is submitted to pressure.

Experience has shown that it requires a very careful adjustment of the several mechanical and physical characters of gunpowder to reduce the rapidity of its action, and at the same time to develope the requisite total pressure and consequent velocity with sufficient uniformity. The first promising result obtained by the late Committee on Gunpowder were simply arrived at by increasing the size of the masses composing the charge; subsequently it was found that the results were greatly improved by paying attention to the density and hardness of the powder, and by adopting measures to promote uniformity in regard to these properties of the powder-particles composing a charge, the importance of which has become more evident as the means available for examining the action of fired gunpowder have been extended and perfected.

A very brief examination only can be attempted of the results which have been arrived at by earlier experiments with regard to the pressure developed by exploding gunpowder, and of those quite recently obtained by the Government Committee on explosive agents.

Although the first attempt was made by a Frenchman, M. de la Hire, in the beginning of last century, to explain the action of fired gunpowder, it was Robins who first investigated the subject experimentally, by carefully determining the quantity of gas generated by the explosion, and by endeavouring to estimate from experimental data the increase of elasticity of the gases due to the temperature developed by the explosion. He came to the conclusion that the permanent gases evolved from powder occupy about 240 times its volume, at normal temperature and pressure, and that the heat generated raised this volume to 1000 times that of the powder, causing the latter therefore to exert a force corresponding to a pressure of about 1000 atmospheres, or 6¾ tons on the square inch. The first experiments, of which the object was a direct determination of the pressure exerted by gunpowder when exploded in closed vessels, were made by Count Rumford in 1793, who confined a small charge of sporting powder (not more than 18 grains), in a very strong wrought-iron vessel, the opening of which was closed by means of a weight. The vessel or species of gun was supported vertically, and the charge was exploded by applying a red-hot ball to the lower extremity of the vessel, which formed a closed vent and was filled with powder. A given charge having been employed, the vessel was closed by a weight which was considered likely to be equivalent to the gaseous pressure to be developed. If this weight was raised by the explosion of the particular charge used, it was increased until it just resisted the force exerted by the explosion; this weight was then taken to represent the pressure exerted by the powder. The results obtained by Rumford were conflicting, but the conclusion arrived at by him was, that the total force developed by the explosion of gunpowder corresponded to 101,021 atmospheres, or a pressure of 662 tons upon the square inch. Rumford endeavoured to reconcile the development of this enormous total pressure with the fact that guns could endure it, by assuming that the explosion of powder takes place very gradually in a gun, being completed only when the shot leaves the bore.

Another method, first suggested by Colonel Cavalli in 1843, of determining the pressure in a gun's bore, consisted in inserting a number of small tubes or gun-barrels into the gun along its length; spherical bullets were inserted into these barrels, and the pressure at different parts of

the gun was estimated by ascertaining the velocities by which these balls were propelled when the gun was fired. An improved form of the same method of experiment was adopted in 1854 by the Prussian Ordnance Committee, but was only applied to guns of small calibre. It consisted in fitting a small gun-barrel into a hole drilled into the powder-chamber of the gun; after the gun was loaded, a cylinder, having the same longitudinal section as that of the projectile in the gun, was inserted into the small barrel. Assuming the pressure in the powder-chamber to be uniform throughout, the cylinder and the shot would travel through equal spaces in the same time, and the cylinder, after having travelled eight inches, would be out of the sphere of action of the gas. If the cylinder had a longitudinal section one-half that of the shot, it would require double the velocity, and so on; and thus, by knowing the relation of the longitudinal section of the cylinder to that of the projectile, the velocity of the latter, after it had prescribed a particular distance, could be ascertained by determining that of the cylinder.

The results of the Prussian experiments indicated that the maximum pressure in a 6-pounder gun is 1100 atmospheres, and in a twelve-pounder 1300 atmospheres. The same method subsequently applied to a 70-pounder rifled gun appears to have given an indication of a pressure of about 3000 atmospheres.

(To be continued).

NOTE ON TRINITRO-THYMO-METHOL.

By ROLAND J. ATCHERLEY.

THYMO-METHOL, prepared by acting upon a solution of thymol in methyl iodide with metallic sodium, is dissolved with the aid of a gentle heat in concentrated sulphuric acid, and added very cautiously, by means of a small pipette, to fuming nitric acid. The resulting deeply-coloured solution is diluted with a quantity of water. A large proportion of a resin will then rise to the surface, which may, when cold, be easily removed, while a fused substance remains at the bottom of the vessel. This, when crystallised from alcohol, constitutes trinitro-thymo-methol. It forms beautiful iridescent plates of a yellowish colour, fusing at 92° C., and exploding when heated on platinum foil. It is only slightly soluble in boiling water, but easily dissolves in alcohol and ether. Sulphuric acid dissolves it likewise; it is, however, re-precipitated on dilution with water in an unaltered state. Analysis shows it to be represented by the formula $C_{11}H_{13}O(NO_2)_3$. I have not yet succeeded in converting it into an amide, but hope shortly to do so, as well as to prepare the mono- and di-nitro derivatives of thymo-methol.

NOTICES OF BOOKS.

The Technical History of Commerce; or, Skilled Labour applied to Production. By JOHN YEATS, LL.D., F.G.S., F.R.G.S., &c., assisted by several Scientific Gentlemen. London: Cassell, Petter, and Galpin.

DR. YEATS considers all branches of industry as grouped under three heads, viz., Materials, Labour, and Commerce; and to each he devotes a volume of his series, of which the present is the second published, the former being entitled "The Natural History of the Raw Materials of Commerce." Industry is divided into:—Mechanical, comprising Engineering, Manufacturing, Mining, &c. Chemical—Bleaching, Dyeing, Smelting, &c. Physiological—Dealing with Agriculture, Gardening, and Cattle-rearing. And Mental, with Education and Government. After considering the origin of the useful arts and the knowledge possessed of them by the ancients, their present application is outlined, and it is from the clear definition of this outline that the full worth of the work obtains. Dr. Yeats thinks with Sir Humphry Davy, that all the great changes of nations are not to be confounded with changes in their dynasties, but that these changes are dependent upon the opinion of the people, and the peculiar spirit of the age and nation. The illustrative facts are drawn from all sources, and greatly from Germany, where the author, it appears, spent some time in studying the application of chemical and mining science. It must be borne in mind that Dr. Yeats is the head-master of a large school, and that this work is written for the use of his boys, not only while they are with him, but to serve the purpose of an introduction to the literature of the particular branch of industry the student may eventually follow, not forgetting that there are many established commercial men to whom Dr. Yeats's work will convey much that is interesting. The work enlarges the scope of our school books, showing how they may be written to be preserved in after life, not for mere curiosity, but for actual information. These volumes should certainly accompany the usual text-books of "our sixth."

CORRESPONDENCE.

SPECTRUM OF LIGHTNING.

To the Editor of the Chemical News.

SIR,—We had here, during a thunderstorm on Monday night, a magnificent display of lightning, the spectra of which I examined, but having only a pocket spectroscope, I was unable to determine the position of the bright bands with any degree of accuracy.

Two narrow blue-green bands most frequently made their appearance; they were somewhat narrower than those of the chloride of copper spectrum, and separated by a wider interval. At times when the flashes were particularly vivid, bands of various degrees of luminous intensity and of breadth were distributed over the whole spectrum; and, during the occurrence of a flash *en zigzag*, a group of narrow ones—two being very brilliant—appeared in the more refrangible part of the red, besides those bands in the blue and green, which were always most conspicuous.

The complexity of these spectra gave me the impression that this department of meteorological chemistry would prove a most promising field of investigation.—I am, &c.,

JOSEPH GIBBONS.

Tywardreath, Cornwall,
August 16, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, July 31, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Second Memoir on the Action of Electricity upon the Coloured Tissues of Plants.—M. Becquerel.

Glacial Origin of the Peat Deposits of the Neufchâtel Jura, and on the Plants met with therein.—Ch. Martius.—A geologico-botanical essay.

New Mineral Found in the Tin Ore Deposit of Montebras (Creuse).—M. Moissenet and M. Des Cloizeaux.—This paper contains a brief description of the results of the mining operations at Montebras, where tin ore is found, and, among other minerals, also a fluo-phosphate of alumina, soda, and lithia, which will be mineralogically known as montebrasite. The composition of this substance, in 100 parts, is quoted as follows:—Fluorine, 26·50; phosphoric acid, 21·80; alumina, 38·20; soda, 6·70; lithia, 6·50; lime, 2·0; quartz (intermixed, not really belonging to the mineral), 2·25; loss by ignition, 0·60. Qualitatively, this mineral contains the same constituents as the amblygonite from Arnsdorff, but in the montebrasite a three times larger quantity of fluorine occurs; the sp. gr. of the last-named mineral is 3·11. The formulæ given are $2(Al_2Fl_3,3MFl)+4Al_2O_3,3PO_5$, and the atomic formula, $Al_4M_3O_9Fl_3P_3$. Wavellite and turquoise are also met with in the tin ore deposit alluded to.

Reversion of the Spectrum-Rays of Metallic Vapours.—A. Cornu.—A lengthy spectroscopical memoir.

New Method of Incineration of Vegetable and Animal Substances, and the application of that method to the Estimation of the Mineral Elements of Yeast.—A. Béchamp.—After first referring at length to the difficulty often experienced by analytical chemists, to ignite and burn off completely certain organic substances, especially such as yield a readily fusible ash, the author proposes the use of nitrate of bismuth in the state of an aqueous solution of known strength to be mixed with the material to be incinerated (in this paper yeast is only mentioned, and it is a well-known fact that that substance is very difficult to burn off completely), provided the water contained in the substance has been previously ascertained by drying at 100°. The nitrate of bismuth solution (the bulk thereof to ignite and calcine readily 100 to 150 grms. of substance should contain from 3 to 4 grms. of oxide of bismuth) having been mixed with a fresh and weighed portion of the yeast, the mixture is first dried gently on a water-bath, next heated on a sand-bath hot enough to cause the mass to blacken, after which it burns away as tinder, and, if required, the ignition is completed over the lamp. Should any fear exist that some metallic bismuth should have been formed, nitric acid is added to the ash, and the heating repeated, so as to destroy the nitrate of bismuth thus formed. The author, not desiring to estimate the chlorine in the ash of the yeast he had operated upon, dissolved that ash in hydrochloric acid, and removed the bismuth by means of sulphuretted hydrogen. This paper contains also a series of results of ash analysis of yeast made by the method alluded to.

Discovery of a Bone Cavern near Montrejeau (South of France).—M. Piette.

Bone Caverns of Baoussé-Roussé (Italy).—E. Rivière.—This and the preceeding paper are contributions to geology and palæontology.

Zeitschrift für Chemie von Beilstein, No. 8, 1871.

The original memoirs and papers contained in this number are—

Conversion of Dichlorhydrine boiling at 174° into that boiling at 182°.—H. Hübner and C. Müller.—By treating an allyl-alcohol (prepared from a dichlorhydrine boiling at 174°) with dry chlorine gas, the authors obtained a dichloride different from that which they expected to obtain (one that should boil at 174°), but a dichlorhydrine boiling at 182°, identical with that which is obtained by the action of chlorine upon allyl-alcohol from glycerine and oxalic acid.

On α Brom-Sulphotoluol and α Sulphotoluol.—H. Hubner and N. M. Terry.—The authors first describe the preparation of solid brom-toluol, a crystalline substance, fusing at 28°, and boiling at 185°; sp. gr. at 30°, 1·3999. This substance was first dissolved in fuming sulphuric acid, and several α sulphotoluol salts prepared. The α sulphotoluol, $C_6H_4CH_3.SO_2OH$, is a crystalline substance, soluble in water. The lead-salt of this acid, $[C_6H_4.CH_3.(SO_2O)]_2Pb+4H_2O$, is a crystalline compound readily soluble in water. Nothing is mentioned in this paper on α brom-sulphotoluol.

The Sulpho-Acids of Benzol.—Dr. H. Rose.—The author describes the preparation of a sulpho-acid of benzol by treating pure nitrobenzol with fuming sulphuric acid, and next forming, first a baryta salt, from which the free sulpho-benzol acid was separated. That free acid is a solid substance, soluble in water and alcohol, hygroscopic, fusing between 60° and 70°, and insoluble in ether. The baryta salt, $C_6H_4NO_2SO_2Ba+H_2O$, is crystalline, yellowish coloured, somewhat soluble in water, and insoluble in alcohol. The paper further contains the catalogical quotation of several other salts of this acid.

Product of Decomposition of the Chlormethyl-Sulphurous Acid.—N. Jazukowitsch.—While preparing trichlormethyl-sulphite of potassa by treating the chloride of the acid alluded to with excess of caustic potassa solution, the author observed the formation of a salt insoluble in water, which was found to be also insoluble in alcohol, and to consist of $CH_2.SO_2.K_2O_2$. This salt is the potassa salt of a bibasic acid, which, however, could not be obtained in free state.

Ethyl-Diacetic Acid and some of its Derivatives.—A. Geuther.—This monograph contains the following sections:—Best method of preparation of ethyl-diacetic acid; action of pentachloride of phosphorus upon ethyl-diacetic acid; monochlor-quartenylic acid; monochlor-tetracylic acid, $C_6H_5ClO_2$; sodium salt—

$$2(C_6H_4ClO_2Na)+H_2O;$$

oily product; quartenylic acid, $C_6H_6O_2$; tetracrylic acid (solid crotonic acid); tetrolic acid; on diethyl-diacetic-amide, and the action of ammonia upon heated ethyl-diacetic acid ether.

Researches on the Allyl Group.—B. Tollens, A. Rinne, and G. Münder.—This essay is divided into the following chapters:—Conversion of allylic alcohol into normal propylic alcohol; oxidation of allylic alcohol; on allyl-cyanide (croto-nitrile); conversion of the chloride of allylic alcohol into the dichlorhydrine isomeric therewith.

Estimation of Chlorine, Bromine, and Iodine according to Carius's Method.—B. Tollens.—The author states mainly that small glass globules containing bromated or other substances, when heated in sealed tubes, along with nitric acid of 1·2 sp. gr., up to 160° and 220°, when made of ordinary glass, lose from 0·0071 to 0·029 grms. in weight; while globules made of Bohemian glass (best combustion-tube glass) lost, after six hours' heating to 220° along with nitric acid, only from 0·0008 to 0·0012 grms. By the application, therefore, of Carius's method, the glass globules should be made of best Bohemian glass, since ordinary glass, even if free from lead, is strongly acted upon by nitric acid under the conditions alluded to.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 6, 1871.

The original papers and memoirs contained in this number relate to geology, palæontology, mineralogy, and geometry.

Les Mondes, July 27, 1871.

This number opens with an article entitled—

Salle du Progrés.—Rev. F. Moigno.—The excellent and enlightened editor of the above-named periodical states, in this short paper, that he intends shortly to open, with the assistance and collaboration of others, a campaign against what the writer terms "l'ignorance, une des grandes plaies de la belle France;" in other words, to begin, in various districts of Paris and localities of France, a series of lectures suited to the general public, and intended to render true, in a moral, material, as well as scientific sense, the "ingenuas didicisse fideliter artes emollit mores nec sinit esse feros."

This number further contains the following matter relating to chemistry and collateral sciences:—

Light and Electricity.—P. Breton.—This paper, illustrated by a woodcut, does not contain a description of any experiment already made, but suggestions on researches which might, if made with care, perhaps tend to illustrate something concerning the nature of the undulations of the ether which produce the phenomena of light and electricity.

Essay on the Comparative Geology of the Vosges, Pyrences, and Central Mountain Plateau of France.—Dr. G. Bleicher.—An important contribution to geology, here briefly reviewed, the original work having been published last year at Colmar.

Best means of bringing Waste Lands into Cultivation.—Rev. F. Moigno.—Although the contents of this paper bear more especially upon France, there is much in it suitable for application to other countries where heath, marsh, and moor land are yet found waiting to be turned to useful account.

New Manometer for Measuring High Pressure of Gases.—V. Regnault.—Illustrated by engravings; while, moreover, the contents of this paper are strictly algebraico-physical.

Aurora Borealis seen and observed in Italy on the 9th, 18th, and 23rd of April last.—Rev. Father Denza, S.J.—To this lengthy paper is added a short appendix, stating that, on the nights of the 7th, 12th, and 18th of June last the phenomenon alluded to was brilliantly seen in various parts of Italy, and accompanied by strong magnetic perturbations.

August 3, 1871.

Central Scientific Office for the Netherlands.—Dr. E. H. von Baumhauer states that, in imitation of what obtains in the United States, where the Smithsonian Institute at Washington is the central office for exchange of publications and periodicals of the learned and scientific societies, it has been arranged that, for the Netherlands, this will be the Hollandsche Maatschappij voor Wetenschappen (Holland Society of Sciences), at Haarlem, to which the *savant* just named is the Secretary. A large number of the various scientific and learned societies in different parts of the Netherlands have intimated their intention of sending and obtaining their exchanges by the mode mentioned. M. J. Baillière and Son, at Paris, are provisionally nominated as the agents of the office at Paris for France.

August 10, 1871.

Origin of the Principal Currents of Air (Wind).—Dr. Lartigue.—A meteorological essay.

Cause of Explosion (Accidental and Spontaneous) of Explosive Substances, and on a Preventative of such occurences.—Dr. Zaliwski.—The author says that the explosive property of the inflammable substance depends upon the hygrometric condition of the atmosphere—that is to say, that gunpowder and other explosive materials become, even without elevation of temperature, spontaneously explosive, and that the smallest trace of oxalic acid is, if mixed with the explodents, sufficient to prevent spontaneous explosion due to the cause alluded to, owing to a catalytic effect which precedes the loss of basic water of the acid alluded to. The author further says that this fact can be readily experimentally proved by adding, to a mixture of sulphur and chlorate of potassa, for instance, or to any other explosive mixture, a certain quantity of oxalic acid, after which these materials may be heated even up to their point of fusion without exploding.

Bayerisches Industrie und Gewerbe Blatt, May, 1871.

This number contains the following original matter relating to chemistry and collateral sciences:—

Schweizer's Coating for Stereochromic and other Purposes.—Dr. Fechtinger.—This lengthy paper contains a detailed account of the results of the practical application of what, in reality, is a peculiar cement or stucco mass, consisting of pulverised chalk, or marble, quartzose sand, cement, and silicate of potassa solution, which, originally employed, and first applied, by M. Schweizer, at Munich, has been used in that city for various architectural and other purposes, among others, the coating of sheets of iron, zinc, &c., upon which coating stereochromy was applied.

Chinese Varnish.—Dr. v. Scherzer.—Under the name of schioliao, the Chinese apply as varnish freshly-defibrinated blood, mixed with powdered slaked lime, and a small quantity of alum, in the proportion of 3 parts of previously-defibrinated fresh blood, 4 parts of lime, and a small quantity of powdered alum. The result is the formation of a glutinous yet fluid mass, which is ready for use at once, and especially used for rendering wood perfectly watertight, and harden its surface. The author states that he has seen in China bags made of straw rendered so impervious for liquids by the application of this varnish as to serve for the transport of oil, while thin millboard painted with this varnish becomes as hard as wood.

Preventatives for the Ignition of Woven Fabrics.—A. Patera.—The author recommends the use of a solution consisting of —Water, 20 parts; borax, 3, and sulphate of magnesia, 2½ parts. These salts are only to be mixed just previous to use. The muslins and other similar fabrics are thoroughly impregnated with the solution, next wrung out, and are, after having become nearly dry, ironed. The use of a mixture of sulphate of ammonia and sulphate of lime is also recommended. And, lastly, attention is called again to the application first made by Fuchs, so far back as 1823, of a solution of silicate of potassa, or soda, for rendering wood, and especially theatrical decorations, fire-proof, that is to say, preventing such from bursting into flame if accidentally ignited.

Action of Moist Ultramarine upon Silver.—J. N. Braunschweizer.—The author relates at length a series of experiments made by him, in order to explain some facts to which his attention had been called by parties, who found that silver foil (perfectly pure silver) and objects made of that metal—spoons and forks—became very deeply black-brown coloured under conditions which seemed to point to the presence of ultramarine (in paper wherein either the objects were packed, or in contact with) as the only cause of the discolouration and tarnishing of the metal alluded to. By the experiments, this opinion was fully confirmed, care being taken to have extra good quality of ultramarine, and to institute comparative experiments with other blue pigments, viz., indigo, litmus, Berlin-blue, mountain-blue, all of which, placed upon clean glass plates, and moistened with distilled water, were left in contact with silver foil for twenty-four hours, with the result that only the foil in contact with ultramarine was blackened. It thus appears that the sulphuret of aluminium present in ultramarine is slowly decomposed, and gives off, when moist, sulphuretted hydrogen.

Improved Mixtures for Red, Green, and Blue Bengal Lights.—J. N. Braunschweizer.—The following mixtures have been found, after a series of experiments, to be the best:—For *red*, 9 parts of nitrate of strontia, 3 parts of shellac, 1½ parts of chlorate of potassa; for *green*, 9 parts of nitrate of baryta, 3 parts of shellac, 1½ parts of chlorate of potassa; for *blue*, 8 parts of ammoniacal sulphate of copper, 6 parts of chlorate of potassa, 1 part of shellac. This latter ingredient need only be coarsely pulverised. The mixtures here alluded to are suitable for use in theatres and rooms, as by the combustion no injurious vapours are given off.

La Revue des Scientifique de la France et de l'Etranger, July 29, 1871.

This number does not contain any original papers bearing upon chemistry and allied sciences.

Journal für Gasbeleuchtung und Wasserversorgung, No. 13, 1871.

This number only contains such original matter as directly bears upon gas- and water-works' engineering and management.

NOTES AND QUERIES.

Logwood Test for Alum in Bread.—Can any of your correspondents inform me how the test for alum in bread, known as the logwood test, is performed, or where I shall find a description of it?—F. B. Munn.

Diamond Dust.—Could your readers tell me, through the medium of your paper, if there is a way of separating glass from jeweller's "diamond dust," the glass having been put in for adulteration?—Josiah Lowe.

Manufacture of Alum.—Desiring to obtain the fullest and latest information on alum manufacture, I should be obliged to your readers for directions. Muspratt, Richardson, and Knapp I have.—A.

Carbolic Acid.—(Reply to "Carbolic.)"—When quite pure—that is to say, free from other constituents of tar—carbolic acid has no disagreeable smell, and may be used by being dissolved in strong acetic acid, and next diluted with water. In the liquid thus obtained, the smell of acetic acid prevails, so as to make the peculiar odour of the carbolic acid quite imperceptible.

TO CORRESPONDENTS.

*** The Students' Number of the Chemical News will be published on Friday, September 8th. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the Education, who have not yet forwarded the necessary information to our Office for publication in that number, will confer a favour by sending it with the least possible delay.

G. Maurice, Paris.—Your communication shall receive attention.

J. G.—The price of Dr. Schellen's work on Spectrum Analysis, reviewed in vol. xxii., p. 284, is 12s. 6d.

Dr. F. Crace Calvert, F.R.S., T. Bloxam, M. M. Pattison Muir, Dr. T. L. Phipson, R. J. Atcherley, Dr. C. R. A. Wright, Dr. Thorpe, N. S. Maskelyne, Dr. J. Emerson Reynolds, and J. Alfred Wanklyn.—These correspondents are thanked for their communications.

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THE CHEMICAL and TOXICOLOGICAL CLASS will meet as usual every Monday and Thursday evening, commencing October 2nd, at 8 p.m.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 614.

LOCALITIES OF DIOPTASE.*

By Professor N. STORY MASKELYNE, F.R.S.

DIOPTASE has hitherto only been known as a product of the copper mine at Altyn Tubeh, in the Kirghese steppes of Tartary, if we except certain reputed localities in Germany; it has been recently met with among old specimens that have been traced to localities in Chili.

One of these was among the specimens preserved in drawers at the British Museum, which have lately been under careful examination with a view to their identification, and another similar specimen was obtained some years since by W. G. Lettsom, Esq., the well-known distinguished mineralogist, from a dealer at Vienna.

The crystals on both are minute but distinct, and are those of dioptase. The gangue is a compact micaceous hæmatite; the locality, traced to an old sale catalogue of Heuland's, is the Rosario Mine, Chili.

It is singular that other specimens of the same mineral should have been found among the carefully preserved treasures of the British Museum. One of these is associated with chrysocolla and ochre on a quartzose veinstone, another occurs as a thin crust on a schorlaceous rock, both being from a Chilian locality. A specimen recently obtained is associated with quartz and eisenkiesel, and is from the Mina del Limbo, Del Salado, Copiapo, Chili.

ON ANDREWSITE.*

By Professor N. STORY MASKELYNE, F.R.S.

A SOMEWHAT well-marked group of minerals would seem to justify the designation of the Dufrenite group, by reason of their having, as a common constituent (or being capable of being so represented), a compound of which the formula is $R_2P_2O_8+R_2H_6O_6$; R being Fe in the case of Dufrenite.

Dufrenite being $Fe_2P_2O_8+R_2H_6O_6$, or, in Berzelian symbols, $\dddot{F}e\dddot{P},\dddot{R}\dot{H}_3$,

Peganite is $\dddot{A}l\dddot{P},\dddot{A}l\dot{H}_3+3\dot{H}$,

Fischerite is $\dddot{A}l\dddot{P},\dddot{A}l\dot{H}_3+5\dot{H}$.

Cacoxene is $\dddot{F}e\dddot{P},\dddot{F}e_2\dot{H}_3+9\dot{H}$.

Wavellite is $2\dddot{A}l\dddot{P},\dddot{A}l_2\dot{H}_3+9\dot{H}$.

A mineral recently found in Cornwall, and sent to the British Museum by Mr. Talling, may perhaps be referred to this group. It has been analysed in the Museum Laboratory, and Professor Maskelyne named it Andrewsite, in honour of the distinguished President of the Chemical Section of the British Association, Dr. Andrews, of Belfast.

Andrewsite occurs in occasional association with a bright green mineral in brilliant minute crystals, presenting a strongly marked resemblance to those of Dufrenite. This green mineral not having been as yet, from the small amount obtained of it, submitted to analysis, is only provisionally termed Dufrenite.

The Andrewsite which it sometimes thus accompanies presents itself in globular forms or in discs with a radiate structure, and in habit curiously resembles wavellite. Its colour is a slightly bluish green; its surface is generally formed of a very thin layer of the mineral provisionally termed Dufrenite, crystals of which occasionally stand out of the globules.

The interior of the globules is sometimes homogeneous, and consists of radiating crystalline fibres; oftener one perceives an almost sudden transition from an outer shell of some thickness, which consists of Andrewsite, into an inner core, formed of a brown mineral.

Seen under the microscope, the two minerals appear to a certain degree to interpenetrate each other, so that the selection of material for analysis is a work of much caution.

The spherules usually stand on the projections of a quartzose veinstone, protruding into a hollow, and covered with a mass of limonite, sometimes carrying a drusy crust of Göthite, and studded occasionally with a few brilliant little crystals of cuprite. The spherules are met with in one or two cases on cuprite formed round a nucleus of native copper. Andrewsite, in fact, contains copper, four analyses of separate specimens giving the percentages of—10·651, 10·702, 10·917, and 11·002.

The analyses of Andrewsite have proved sufficiently concordant to justify the formula—

$$3\{Fe_2P_2O_8+Fe_2H_6O_6\}+CuP_2O_8,$$

$$\text{or } 3\{\dddot{F}e\dddot{P},\dddot{F}e\dot{H}_3\}+\dddot{C}u_3\dddot{P},$$

in which, however, a portion of the ferric phosphate is replaced, by ferrous phosphate, as in Vivianite is frequently the case with the two phosphates.

The parallelism of Chenevixite ($Cu_3As_2O_8+Fe_2H_6O_6$) with a portion of the above formula is worthy of attention, and may justify the formula being written as—

$$2\{Fe_2P_2O_8+Fe_2H_6O_6\}+Cu_3P_2O_8+Fe_2H_6O_6+Fe_3P_2O_8.$$

A larger supply of the mineral will no doubt soon be forthcoming, when the formula may be fixed on the foundation of more certain analyses. The specific gravity of this mineral is 3·475, that of Dufrenite being (from Siegen) 3·2 to 3·4.

The chalkosiderite of Ullmann, the name by which nearly sixty years ago he designated a thin crystalline coating overlying the radiated variety of the Grüneisenstein (Dufrenite) of the Hollerter Zug, Sayn, Westphalia, does not seem to have been analysed by him. He states it to contain copper, but the subsequent analyses of Grüneisenstein do not appear to confirm this statement; indeed it appears more nearly to resemble the green crystallised mineral which has in this note been provisionally described as Dufrenite.

ON THE GOLD ORE OF NOVA SCOTIA.*

By Dr. T. L. PHIPSON, F.C.S.

THE gold-bearing rocks of Nova Scotia extend along the Atlantic border of the province for a distance of more than 300 miles. They are 12,000 feet in thickness, and are worked, in one district or another, through a vertical space of 6000 feet.

These rocks consist of clay slate and quartz, interstratified, and are supposed to be of lower Silurian age—in some places lying directly upon the gneiss, at others on the Cambrian rocks which cover the gneiss.

The other minerals besides gold found in this formation in Nova Scotia are sesquioxide of manganese, iron pyrites, mispickel (abundant), zinc blende, galena, copper pyrites (sometimes), calcspar, native copper, cuprite, mica, sulphide of molybdenum, malachite, and oxide of iron. But at least one-third of the country is yet unexplored, though it has been 120 years under uninterrupted British rule. In no place has the mining exceeded 300 feet from surface, and it is asserted to be well known that the quartz

* Read before the British Association, Edinburgh Meeting, Section B.

* Read before the British Association, Edinburgh Meeting, Section C.

increases in richness with the depth. The few mines worked from 1860 to 1867 produced together about 3 tons weight (English) of gold, and since then the yield has gone on steadily increasing. I have lately examined a certain number of fine specimens of the above-mentioned rocks from the Pioneer Mine, in the Cariboo district, which has been recently opened. Two of these specimens weighed respectively 12¼ lbs. and 8¼ lbs. avoirdupois. They consist of a mixture of white quartz and dark green schist (termed clay-slate in the country). A fair sample of these two stones was taken, and 15 grms. of it treated with nitro-hydrochloric acid; the gold being precipitated as usual by sulphate of iron weighed 9 centigrammes. Another analysis gave, on 100 parts—

Gold	0·60
Silver	0·04

The gold stamped out of some rich specimens gave—

Gold	93·75
Silver	6·25
	100·00

which is similar to the richer kind of Californian gold.

The average yield of the mines now regularly working by the amalgamation process is about 1 ounce (troy) per ton; but much gold is wasted as well as mercury, as the ore is often very sulphurous, and roasting has hitherto failed from being incompletely carried out without kilns. In some instances the yield has been five to ten times as large, and in many districts, probably 3 or 4 ounces of gold per ton of ore could be reckoned on for a lengthened period. I am of opinion that a moderate amount of English capital and enterprise would soon make this colony one of the most successful gold regions on the globe.

I have examined the green schistous rock which accompanies the white quartz in the Cariboo district above-named, and which, like the quartz, contains gold. I have detected a notable amount of glucina in it and traces of some of the rarer earths. It is a dark leek-green schist, with an unctuous feel, like talc, gives a nearly white powder, which loses 2·32 per cent of water at a red heat, and takes a reddish tinge. It is only fusible with difficulty upon the thinnest edges before the blowpipe, and then whitens. The results of the only analysis I have made of it are as follows:—

Water	2·32
Silicic acid	41·20
Alumina	22·00
Glucina	0·33
Yttria and earths insoluble in potash	minute quantity
Oxide of manganese	2·20
Protoxide of iron	15·47
Magnesia	1·44
Lime	1·79
Alkalies	7·65
Portion not attacked by $KOCO_2$ + $NaOCO_2$, with a little gold and silver.	5·60
	100·00

Whether this schistous rock should be termed *clay-slate, talc-schist, mica-slate, nacrite, or talcite*, is a question I must leave to the geologist, the composition of all these rocks presenting much similarity. There is a small quantity of peroxide of iron calculated here as protoxide. Gold is present in most of the minerals that are found in the quartz and green schist, especially in the arsenical pyrites and the iron pyrites, some specimens of which are very rich. I have little doubt that vanadic acid, titanic acid, and perhaps zirconia, could be detected in all these schistous rocks, as well as the rarer earths mentioned above, but I had only a limited period to devote to their examination.

ANALYSIS OF ENTIRE WHEATEN FLOUR.

By A. H. CHURCH, M.A.,
Professor of Chemistry, Royal Agricultural College, Cirencester.

It is well known that fine flour contains less nitrogen than the whole wheat grain. If we endeavour to supplement this deficiency of nitrogenous compounds by the addition of bran, though the chemical conditions of a satisfactory food rich in flesh-formers may be fulfilled, the mechanical texture of the material leaves much to be desired. Anxious to ascertain whether any article of commerce really contained all the materials of the wheat grain in desirable proportions, I made some trials of certain gluten preparations and of Chapman's Entire Wheaten Flour. The former scarcely fulfilled the necessary conditions, so far, at least, as fat and mineral matters were concerned, but the latter gave very encouraging results. Two determinations of nitrogen in the entire wheaten flour gave respectively

2·11 per cent nitrogen
2·12 ,, ,,

The mean of these results, when multiplied by the proper factor, 6·33, gives us 13·39 per cent of albumenoids or flesh-formers as contained in this preparation. This is a very large amount, seldom reached, except in certain horny long-grained foreign wheats, or in the translucent grains* of some of our home grown corn. Nor did the ash determination in this flour yield unfavourable indications. While the whole grain of wheat yields generally about 1·6 per cent of ash, the sample of flour now under notice gave 1·04 per cent, which compares well with the low percentage of 0·6 found in ordinary fine flour. This ash was also unusually rich in the most important ingredient of the mineral matter of the wheat grain, containing, as it did, no less than 51·8 per cent of anhydrous phosphoric acid, while the ash of ordinary whole wheat gives, on an average, no more than 46·2 per cent of this ingredient.

DETERMINATION OF NICKEL AND COPPER BY THE BATTERY.

By J. M. MERRICK, S.B.

The following analyses were undertaken recently to satisfy myself in regard to the accuracy of the electro-magnetic method of determining several metals. They show, in regard to nickel at least, what has already been demonstrated in the case of copper (*vide* Wolcott Gibbs, *Am. Journ. Sci.*, xxxix., pp. 64—65), that, where this method can be used, it is far more accurate, elegant, and satisfactory than any other.

The process employed is very simple. A platinum crucible, holding the solution to be decomposed, was made the cathode of a two- or three-cell Grove's battery, by setting it in the coiled-up end of the wire from the zinc plate, and the circuit completed by dipping into the solution, through a perforated porcelain cover, a platinum wire from the other pole. Some presumably-pure double sulphate of nickel and ammonia was first analysed. One gramme of this salt was found to require about 2½ hours for its reduction, with the aid of a battery of two ordinary Grove's cells.

(*a*). 0·9495 grm. of double sulphate gave 0·1405 grm. of metallic nickel = 14·79 per cent.
(*b*). 0·4444 grm. of double sulphate gave 0·0657 grm. of metallic nickel = 14·78 per cent.
(*c*). 0·134 grm. of double sulphate gave 0·0198 grm. of metallic nickel = 14·77 per cent.

The double sulphate of nickel and ammonia contains, theoretically, 14·72 per cent of nickel (*vide* Gmelin, "Handbook," vol. v., p. 381).

Theory.	*a.*	*b.*	*c.*
14·72	14·79	14·78	14·77

* *Vide* "How Crops Grow," Church and Dyer's edition, pp. 385, 391.

The above analysed salt, which had been supposed to be perfectly pure, had lain for some time in the sun, which may have caused a minute loss of water and so an increased amount—0·07, 0·06, 0·05 per cent; or, possibly, the deposited nickel may have faintly oxidised in drying the crucible.

The next salt experimented with was a commercial sulphate of nickel in coarse powder, roughly dried between folds of filter-paper.

(*d*). 0·85 grm. of sulphate of nickel gave 0·1878 grm. of metallic nickel = 22·07 per cent.
(*e*). 0·3282 grm. of sulphate of nickel gave 0·0718 grm. metallic nickel = 21·87 per cent.
(*f*). 0·4367 grm. of sulphate of nickel gave 0·0954 grm. metallic nickel = 21·84 per cent.
(*g*). 0·42 grm. of sulphate of nickel gave 0·09 grm. of metallic nickel = 21·43 per cent.
(*h*). 0·458 grm. of sulphate of nickel gave 0·101 grm. of metallic nickel = 22·05 per cent.

Sulphate of nickel, of the formula $NiO.SO_3.7HO$, should contain 20·71 per cent of nickel.

Theory.	*d.*	*e.*	*f.*	*g.*	*h.*
20·71	22·07	22·87·	21·84	21·43	22·05

This sulphate of nickel contained crystals of different sizes and of unlike appearance, and no attempt was made to purify it, yet the results obtained, though too high, and showing that the salt was unduly dry, do not differ very widely. The extreme difference is 0·64 per cent, and the least 0·02 per cent.

The double sulphate of nickel and potassium, presumably perfectly pure and twice re-crystallised, was next analysed by the aid of the battery. As this salt does not deposit metal, but only oxide, when no ammonia is present, a considerable excess of ammonia was added to the solution in the crucible.

(*i*). 0·5175 grm. of double sulphate of nickel and potassium gave 0·069 grm. of metallic nickel = 13·33 per cent.
(*j*). 0·305 grm. of double sulphate of nickel and potassium gave 0·0408 grm. of metallic nickel = 13·37 per cent.
(*k*). 0·5 grm. of double sulphate of nickel and potassium gave 0·0662 grm. metallic nickel = 13·24 per cent.

Theory.	*i.*	*j.*	*k.*
13·29	13·33	13·37	13.24

The extremes here are +0·09 and −0·05 per cent.

A separation of copper and nickel was next attempted. The nickel and copper salts having been dissolved in hot water, the solution was made very strongly acid, and the copper first deposited out from the acid solution. The solution was then made strongly alkaline with ammonia, and the nickel plated out on the same crucible over the copper deposit. Sulphate of copper and the double sulphate of nickel and ammonia were employed. The results obtained, as well as some results with salts of zinc, must be reserved for another paper.

Laboratory, 59, Broad Street,
Boston, U.S., Aug. 1, 1871.

ON RECENT INVESTIGATIONS AND APPLICATIONS OF EXPLOSIVE AGENTS.*

By F. A. ABEL, F.R.S., Treas. C.S.

(Continued from p. 96).

SOME very interesting experiments were instituted in the United States, in 1857, 8, and 9, by Major Rodman, who registered the pressures exerted in a gun on the explosion of a charge, by means of an ingenious instrument, well known as Rodman's Pressure Piston, which has since been extensively employed in similar experiments in France, Prussia, and other countries. To ascertain the pressure exerted in any portion of the gun's bore, Major Rodman drilled a hole in the gun at that part, and inserted a hollow cylinder carrying the indicating apparatus. This consisted of an indenting tool, resting upon a piston which fitted into the part of the cylinder nearest to the gun's bore. A small metal cup was inserted at the back of the piston, to guard against any rush of gas past the latter. A flat piece of soft copper was screwed down firmly against the knife-edge of the indenting tool, so that, when the piston was acted upon by the pressure which the exploding powder exerted, the knife was forced into the copper, producing a cut, the dimensions of which were accurately measured, and compared with indentations produced by application of known pressures.

Major Rodman applied this instrument to guns of various calibres up to 11 inches, and instituted several series of experiments, employing in the first instance different natures of cartridges, and afterwards powders of different size of grain, ranging from one to four inches in diameter. The results arrived at presented several anomalies and serious contradictions, but those obtained with the powders of different sizes were, generally, of a nature to warrant a conclusion similar to that arrived at by the late Committee on Gunpowder in the earlier stage of their experiments, namely, that the velocities furnished by small-grain gunpowder may be obtained, with a reduced strain upon the arm, by adapting the size of powder to the calibre of the gun. Major Rodman also fitted this pressure-gauge to a very strong vessel, in which he exploded charges of powder ranging from 700 to 7000 grains, allowing the products to escape through a vent 0·1″ in diameter. The pressure-indications obtained by him varied very greatly; in some they corresponded to 4900 atmospheres (or 32 tons to the square inch), while in the others they ranged as high as 12,400 atmospheres (or 82 tons).

In 1869, the present Committee on Explosive Substances were entrusted by Government with the investigation of the action of gunpowder, which had been taken up by the late Ordnance Select Committee in continuation of the Gunpowder Committee's experiments—the special object of the researches being to ascertain the pressures exercised in guns of different calibres by different descriptions of powder, and to deduce from the results the conditions to be fulfilled by a powder susceptible of safe and efficient employment in very large charges. In their earlier experiments the committee employed Rodman's pressure-gauge as one method of registering the pressure developed; but the very variable and anomalous results which that instrument furnished led them to devise a modification of it, in which the principal sources of error attending the use of the Rodman gauge appear to have been successfully avoided, and which, under the name of the crusher gauge, has been since employed throughout the Committee's experiments, in conjunction with another instrument, which will be directly referred to.

The crusher gauge consists of a hollow steel screw-plug, which, like the Rodman gauge, is inserted into holes drilled into the gun at the powder chamber, and at various other parts of the bore. The extremity of the plug nearest the charge is closed by a piston which presses against one end of a soft copper cylinder held by springs in the centre of a small chamber in the plug. The other end of the copper cylinder rests against an anvil. When the gun is fired the piston is pressed against the copper cylinder, and the latter is consequently compressed, thus registering the maximum of force exerted at that particular part of the gun.

The other instrument employed by the committee is a chronoscope, devised and elaborated by Captain A. Noble, by means of which they have been enabled to determine with ease and precision the time occupied by the projectile in traversing different parts of the bore of a gun. The principle of this instrument consists in registering, by means of electric discharges, upon a recording surface, which travels at a very high and uniform speed, the precise

* A Lecture delivered to the Members of the British Association at Edinburgh, August, 1871.

moment when a shot passes certain points in the bore. A series (eight or more) of thin metal disks, 36 inches in circumference fixed upon one horizontal shaft, are made to revolve very rapidly, by means of a heavy descending weight through a train of multiplying gear.

A stop-clock, which can be connected and disconnected at pleasure with one of the revolving shafts of the machine, serves to determine the precise rate at which the circumferences of the disks revolve. This is about 1200 inches per second, so that one inch represents the 1200th part of a second; and as, by a vernier attached to the instrument for the purpose of reading the results, an inch can easily be divided into 1000 parts, it is evident that the instrument is capable of recording differences of time less than one-millionth part of a second.

Upon the discharge of the gun, which is placed in connection with this instrument, the exact moment when the shot passes a particular point in the bore is recorded on one of the disks during the time that these are revolving at the speed just mentioned. The manner in which this is accomplished is as follows:—At definite distances from each other a number of hollow steel plugs, corresponding to the number of disks of the chronoscope, are screwed into holes drilled in the gun to receive them. Each of these plugs carries, at the end which is screwed in as far as the bore, after the gun is loaded, a steel cutter, which projects very slightly into the bore, and is held in position by a fine insulated wire, having its extremities protruding at the end of the plug, and therefore outside the gun. Each of these wires is then connected with conducting wires which bring it into circuit with a small voltaic battery, and with the primary wire of a volta induction coil, so that, when this arrangement is complete, a distinct voltaic current circulates through each insulated wire in the gun, and through the primary wire of a distinct induction coil. One end of the secondary wire of these coils is connected with the revolving disks, the peripheries of which are covered with strips of white paper coated with lamp-black, and the other end of each secondary wire is connected with a well insulated pointed discharger, there being one of these fixed in front of each disk, with its points adjusted so as to be just clear of the edge of the disk. When the disks are revolving at the full speed, the rate of which is ascertained by means of the stop-clock, the gun is fired, and as the shot rushes past the cutters which project slightly in the bore, it presses each one in succession level with the surface, and thereby causes it to cut the insulated wire. The primary current is consequently interrupted, and the induced current, which is thereby instantaneously developed in the secondary wire of the coil, passes from the particular discharger to the adjacent disk, producing a minute perforation in the paper at the point where it jumps across to the disk, and burning away the lamp-black at that point, so that a readily discernible mark is thus produced. Supposing it possible that all the primary wires could be severed at one and the same moment, then, as the disks are all travelling at the same speed, the spots which mark the discharge of the induced current upon each individual disk would be in exactly corresponding positions, and would therefore form a straight line across the disks; but as they are severed in succession, the series of spots follow each other upon the several disks—the distance between the spot on the one disk and that on the next being small in proportion to the velocity with which the shot has moved from one point to another in the gun.

Some idea is conveyed of the minute intervals of time which are measured by means of this chronoscope, by the fact that the distances between the parts of the 10-inch gun at which the time-records are obtained are in some distances only 2·4 inches, while the total time the projectile takes to reach the muzzle of that gun (a distance of 100 inches) when fired with a battering charge, is about the one-hundredth part of a second.

It will be seen from the foregoing outline of the nature and employment of this instrument, that by its means the time is recorded which the shot occupies, from the commencement of motion, in reaching different parts of the gun's bore; from these time-records are deduced the velocity with which the shot is passing through different parts of the bore, and the pressures in the gun which correspond to the velocities. With the aid of this instrument, and the crusher gauge employed simultaneously with it, the Committee on Explosives have compared the action in the gun of the powders hitherto used in the service with several gunpowders of foreign manufacture, and particularly with certain descriptions of powder which have been specially manufactured for employment in large charges. Guided by the results obtained, they have succeeded in producing a description of gunpowder (known as "pebble-powder") the physical and mechanical characters of which have been so adjusted with reference to one another, that the capabilities of large guns have become more thoroughly developed, and their powers of endurance at the same time much less severely tried, by its employment, than by that of any other descriptions of gunpowder which have been specially devised with those objects in view during the last four years. As regards the size of its pebble-shaped masses, this powder bears great similarity to one of the earlier experimental powders tried by the Gunpowder Committee (in 1859), which served as the starting-point in the development of pellet-powder; but it presents important differences in respect to density, hardness, and uniformity of form of the masses, and it is to the combined influence of these points of difference, in reducing the rapidity with which the pressure is developed in the gun, that pebble-powder owes its efficiency.

A comparison of the results arrived at, by means of the chronoscope and a 10-inch gun, with the powder hitherto used in all rifled cannon, known as R. L. G. powder, with the Russian prismatic powder (which for a time was regarded as superior to all other varieties), and with pebble-powder, at once demonstrates the superiority of the latter. The prismatic powder is shown by these results to light very slowly in the gun, and afterwards to burn rapidly, though not so rapidly as the R. L. G. powder. The slow lighting appears to be due to the fact that the prisms have a very hard and difficultly ignitable coating, which has been produced by the concentration of some of the saltpetre upon the surface of the masses, consequent upon the powder containing when pressed a considerable proportion of water, which, in evaporating, draws the saltpetre towards the exterior of the masses. The subsequent rapid burning of the prismatic powder is due to its comparatively low density. The old R. L. G. is both a rapidly inflammable and a very quick-burning powder when used in large charges, on account of the small size of the particles and their comparatively low density; while the large particles of the dense and comparatively hard pebble-powder light somewhat slowly, and also burn slowly as compared with the others. It should be mentioned that pellet-powder, of comparatively low density, as hitherto made for the service, approaches R. L. G. in the rapidity of its explosion when used in *large* charges, but that, when its density is assimilated to that which has been found most suitable for pebble-powder, it yields results similar to the latter, and there is little doubt that pellet-powder, with this modification, will prove interchangeable with pebble-powder. A comparison of curves, representing the velocities and pressures obtained with pebble, prismatic, and R. L. G. powders, in different parts of the gun, as deduced from the chronoscope results, shows that the velocities of the two first commence by being considerably below that of R. L. G., but that they gradually reach and pass it, the shot leaving the gun at a very considerably higher velocity (that of the pebble being the greatest). These curves also exhibit most important differences with regard to the pressure, the maximum being considerably greater with R. L. G. than with the other two, while the area of the pressure is much greater with these than with R. L. G. It should be stated that in ex-

periments instituted with the 10-inch gun, and even with the 12-inch 25-ton gun, the pressures recorded by the *crusher gauge*, which has been referred to, agree very well with the pressures deduced from the chronoscope results when pebble, prismatic, or pellet powder is used; but that, when R. L. G. or the old L. G. cannon-powder is employed, very considerable and perplexing anomalies are observed, not only between the results of the two methods of experiment, but also between the individual results furnished by the crusher gauge, applied in one and the same round in different parts of the powder-chambers. These anomalous results have been carefully discussed by Captain A. Noble, in a discourse recently delivered by him at the Royal Institution. The scope of the present Lecture does not permit of a full examination of their probable cause; it may, however, be stated that they appear to be due to a wave-action which is set up in the gases, consequent upon the *vis viva* acquired by these, especially with a rapidly-burning charge, before the shot begins to move in the gun, the *vis viva* being re-converted into pressure at the seat of the shot, and thus giving rise to intense local pressures for exceedingly minute periods of time. It has been shown in the course of the Woolwich experiments that, even with the slow-burning powders, pebble and pellet, when the charge is ignited at the point farthest from the shot, or when the cartridges are greatly increased in length, these intense local pressures, observed with the quick-burning powders, are also developed—a result which is greatly in support of the view that they originate in the *vis viva* acquired by the products of explosion, due to the distance which these travel before they are checked by the shot. An experiment made by Robins, in which he placed a bullet sixteen inches away from the ordinary charge in a musket-barrel, and bulged and burst the latter near the seat of the shot by the explosion, leads to the same explanation; and many anomalous results obtained with the Rodman pressure-gauge are obviously also ascribable to the *vis viva* acquired by the gases in the cylinder before they reach the piston which acts upon the cutter at some distance from the bore of the gun.

These somewhat perplexing results have been referred to mainly to show that although great advance has been made in the subject of the adaptation of powder to the ordnance of the present day, much still remains to be done before all conditions are understood which have to be fulfilled in the production of gunpowder thoroughly suited to different guns. There is little question that a powder which is in all respects most suitable for a 7-inch gun will not be equally efficient when applied in a 10-inch gun, and, most probably, the theoretically correct system of meeting the requirements essential to the safe development of the full powers of guns of large size would be the preparation of a special powder for almost every calibre of gun. The practical objections to such a course are, however, obviously insurmountable; hence the result to be aimed at is, the production of a powder which, while fairly utilising the powers of the smaller of our heavy guns, may be safely applied in such charges as are calculated to develope the full value of the largest ordnance.

By the employment of pebble or pellet powder, as now manufactured, not only is the strain upon the guns, up to that of 25 tons, greatly reduced, when velocities equal to those furnished by the R. L. G. powder are attained, but we are, moreover, enabled to obtain from these guns very considerably increased effects without submitting them to a greater strain than they would be exposed to in employing the former service powder to obtain the standard results. But in passing from the 25-ton gun to that of 35 tons, which is designed for a 700-lb. projectile, and a very much heavier powder-charge than has hitherto been used, the satisfactory results furnished by the new powder in other guns are less readily attainable, and it is still uncertain whether, and if so, in what way, further modifications in the manufacture will have to be introduced to meet the requirements of the largest guns. The more searchingly the nature of the action of fired gunpowder is investigated, and the more the methods of investigation are varied, the sooner, and the more readily and completely, may we hope to fulfil those conditions in its manufacture which will thoroughly establish its efficiency when applied to ordnance of all calibres. The subject is at present receiving in several quarters the careful study and practical investigation which it merits; and before passing to other topics which have to be discussed in this lecture, attention must be briefly directed to a special line of investigation now being pursued by Captain A. Noble, which promises to throw important additional light upon the nature of gunpowder as a propelling agent.

Count Rumford's early attempts to determine the pressure of fired gunpowder by exploding very small charges in a confined space, and experiments of a similar nature instituted some time afterwards by Major Rodman, have already been noticed. The conclusions to which these two experimenters were led by their results, as regards the pressure exerted by gunpowder, differed greatly from each other, and also from the conclusions arrived at in 1857 by Bunsen and Schischkoff, after an elaborate experimental investigation into the nature of the transformation which powder undergoes upon explosion, and of the heat developed when powder is fired in a close chamber. The latter was estimated at 3340° C., or 5980° F., and the pressure which they deduced from their experimental data as the maximum which powder can attain in a closed vessel was about 4374 atmospheres, or about 29 tons in the square inch. This result is no doubt nearer the truth than the estimates made by earlier experimenters; but recent experiments, which will be immediately referred to, appear to have shown conclusively that Bunsen and Schischkoff's estimate of the pressure of fired gunpowder is considerably too low, just as that of Piobert, which is founded upon the assumption that the *solid* products exist as vapour at the time of explosion, and is fixed at about 64 tons (or 9600 atmospheres), is regarded by many as considerably too high. Berthelot, who, like many other eminent scientific Parisians, was impelled by the exigencies of the period, during the recent ever-memorable siege of Paris, to devote his energies and talent to subjects of immediate practical importance connected with the defence of that city, has made an elaborate theoretical investigation into the force exerted by different kinds of gunpowder and by other explosive agents. In criticising the deductions made by Bunsen and Schischkoff, from their experiments with regard to the pressure of fired gunpowder, he points out that they have greatly under-estimated the latter, because they neglected to take into account the effect of the enormous amount of heat liberated by the compression of the gases when powder is exploded in a confined space; in other words, because the temperature of combustion was calculated upon a volume equal to that of the gases measured at zero and at normal atmospheric pressure, instead of upon *a volume equal to that of the powder itself*, to which volume the gases are obviously condensed when powder is exploded in its own space. He discusses the probable influence upon the pressure exerted by the dissociation of the gaseous products of explosion, at the very high temperature developed at the time of their generation; the counteracting influence of the pressure to which the gases are subject; the cooling effect of the expansion of gas while the shot is being propelled from the gun; and the probable consequent continual disengagement of heat, resulting from new chemical combinations which were not compatible with the original high temperature. The estimate which Berthelot is led to form of the pressure of fired gunpowder is not far below that which Rumford arrived at; thus, he gives the pressure of war-powder, exploded in its own space, as 62,700 atmospheres, an estimate about fourteen times greater than that which Bunsen and Schischkoff based their analytical data upon. His conclusions are not as yet borne out by experimental results.

The analytical examination instituted by Bunsen and

Schischkoff of the products of explosion of gunpowder dispelled the confidence up to that time entertained in the old theory of the chemical change of gunpowder, which assumed, as already stated, the conversion of the carbon into carbonic acid, or carbonic oxide, or both, and the conversion of the sulphur into potassium sulphide. According to their analyses, the largest proportion of the sulphur is oxidised to sulphuric acid potassium sulphide being one of the smallest products of the change. While there is no doubt that the old theory of the decomposition of powder is very wide of the actual truth, it is generally considered that the method pursued by Bunsen and Schischkoff in burning gunpowder, with the view of collecting the products for analysis, was not calculated to furnish results fairly respesenting those which would be obtained by exploding gunpowder in a closed vessel, as in the chamber of a gun. Some experiments, subsequently made by Karolyi, in which he exploded very small charges under conditions more nearly approximating to those of the actual employment of gunpowder, furnished analytical results not very greatly at variance with those of Bunsen and Schischkoff, but the value to be attached to them appears likely to be definitely determined before long by the experiments upon which Captain A. Noble is at present engaged. In iron vessels of great strength he explodes, by electric agency, charges of gunpowder ranging up to 2 pounds; the space in which the charges are fired is varied from that entirely filled by the powder to that in which the latter occupies only 10 per cent of the space, and the vessel is fitted with a crusher gauge, by which the maximum pressure developed by the explosion is recorded. The gases are in all instances entirely confined, and are allowed to escape gradually, as soon as expedient, after the explosion, with a view to the measurement of their volume and the collection of portions for analysis (their examination and that of the solid products having been undertaken by myself). It would be premature to enter upon any account of the analytical and other results furnished up to the present time by these experiments; it may be stated, however, that the maximum pressure of fired gunpowder, unrelieved by expansion, has been found to be about 40 tons to the square inch, and that an examination of the relation between the tension and density of the powder-gases, obtained in a closed chamber, furnished results closely corresponding with those deduced from the observation of the tension of gases in the bores of guns, made by the Committee on Explosives.

The imperfect outline which has been given of the investigations, both scientific and practical, which have been instituted during the last two or three years, and are still in progress, will suffice to show that these have not merely an important direct bearing upon requirements which the recent great progress in the construction of artillery has created, but that they are also contributing largely to the attainment of more correct and precise information with regard to the action of gunpowder when exploded in a confined space, and the operation of the various modifying influences which may be brought to bear upon it.

(To be continued).

FACTS DEVELOPED BY THE WORKING OF HEMATITE ORES IN THE ULVERSTONE AND WHITEHAVEN DISTRICTS, FROM 1844 to 1871.*

By THOMAS AINSWORTH.

I MUST preface the remarks I am permitted to make to you to-day by drawing your attention to the *Report of the Proceedings of the British Association for the Advancement of Science*, 1870, pp. 9 and 10. You will find there the following letter from Professor Stokes on the part of the committee appointed at Exeter to confer with Her Majesty's Government as to the completion of the investigations into the composition and geological distribution of the hematite iron ores of Great Britain and Ireland.

"To the Rt. Hon. the EARL DE GREY AND RIPON, Lord President of the Council on Education.

"Lensfield Cottage, Cambridge,
"December 17th, 1869.

"My Lord,—I have the honour to inform your Lordship that, at the last meeting of the British Association for the Advancement of Science a resolution was passed appointing a committee for the purpose of calling the attention of Her Majesty's Government to the importance of completing without delay the valuable investigation into the composition and geological distribution of the hematite iron ores of Great Britain and Ireland, which has been already in part published in the *Memoirs of the Geological Survey*. Your Lordship is doubtless aware of the remarkable process invented some years ago by Mr. Bessemer for the conversion of crude cast-iron into steel or wrought-iron, a process by the application of which, those important materials can be manufactured at a much cheaper rate than formerly. The royalty which at present exists on iron, to which the Bessemer process has been applied, will shortly expire, and its expiration will probably give a great impetus to the iron trade of the country.

"It is not, however, every iron ore that ironmasters have been in the habit of employing which can be used for the production of cast-iron destined for conversion by the Bessemer process—for there are certain impurities which that process fails to remove, and which are extremely injurious to steel or wrought-iron. This difficulty is got over by peparing the iron from hematite, an iron ore which is free from those impurities. Accordingly, on the expiration of the Bessemer royalty, a great demand for hematite is likely to arise, and it will be important for the iron trade of the country that it should be known where hematite is to be found. For many of the counties of England the requisite information is contained in the *Memoirs* referred to in the resolution quoted above, and the object of the British Association is merely to urge on Her Majesty's Government the importance of continuing and completing without delay the investigation thus so ably begun.

"Although the application of the British Association relates to trade, I have addressed myself to your Lordship rather than to the President of the Board of Trade, because it is to be presumed that the investigation would be best completed by the same body by which it was begun, viz., the staff of the Geological Survey, and that belongs to the department over which your Lordship presides.

"The committee will be ready to wait on your Lordship should you think a personal interview expedient. The committee consists of Professor Harkness, President of the Geological Section at the Exeter Meeting of the British Association; R. Godwin Austen, Esq., F.R.S., Vice-President, and myself."—I have the honour to be, &c., G. G. STOKES.

To this application the following reply was received:—

"Science and Art Department, London, W.
"February 8, 1870.

"Sir,—Your letter to the Lord President of the 17th of December, 1869, stating that at the last meeting of the British Association for the Advancement of Science a resolution was passed appointing a committee for the purpose of calling the attention of Her Majesty's Government to the importance of completing without delay the valuable investigation into the composition and geological distribution of the hematite iron ores of Great Britain and Ireland, which has been already in part published in the *Memoirs of the Geological Survey*, has been under the consideration of the Lords of the Committee of Council on Education.

* Read before the British Association, Edinburgh Meeting Section B.

"I am directed by their Lordships to inform you that, after consulting with Sir Roderick Murchison on the subject, they have come to the conclusion that they are not in a position to direct that the former investigation shall be continued by the officers of the Geological Survey.

"The investigation referred to was not made at the public cost, and it does not appear to my Lords that a special inquiry of this nature, involving considerable additional expense, falls within the object for which the sum voted by Parliament for the geological survey has been granted. I am, Sir, your obedient servant,

"NORMAN M'LEOD, Assistant Secretary.

"To Professor Stokes, M.A., F.R.S.,
"Lensfield Cottage, Cambridge.

I quite agree in all that has hitherto been done in this matter—that is, in the application to the Council on Education, for I think that to it and not to the Board of Trade this application should be made, but I quite agree in the view taken by the Council on Education, fortified as it is by the opinion expressed by the venerable and respected member of this association, Sir Roderick Murchison, and I hope the day is far distant when, as a nation, we are to ask for Government aid and assistance in every little difficulty, for, were it granted for the asking, the Anglo-Saxon characteristic of self-reliance would soon be undermined, and the English, while they lost the reputation of being a nation of shopkeepers, might probably obtain that of waiters on Providence incapable of private enterprise.

Now I do not not profess to be either a geologist or a chemist, but merely an owner and worker of hematite iron ore mines for nearly thirty years, an observer and recorder of some facts which my locality has presented to me, and which the kindness and intelligence of friends in other districts whose names I shall introduce to you have enabled me to verify from their longer experience. I shall speak of facts and not of theories, and I must premise that I shall refer to rocks and formations only by their common names and in their widest acceptations, and not according to the particular and minute classifications of the geologist.

The facts which I wish to bring before you came to my notice in the following order. When I came to reside in West Cumberland, a friend of mine had opened a colliery in the parish of Cleator, the proceeds of which were larger than could be disposed of in the neighbourhood, and hematite ore having been worked in the district to some extent for many years and exported to Wales, Scotland, and other iron-making countries, it seemed to us a reasonable speculation to retain the ore in the country and use it with the surplus coal. A company was formed to build furnaces on a site adjacent to the colliery; limestone and hematite iron ore being in close proximity thereto. These furnaces are the present Cleator Moor furnaces, belonging to the Whitehaven Hematite Iron Company. Limestone, as I before said, adjoined the site, and the owner of the limestone quarry was at first quite willing to sell us at a reasonable price what limestone we required for smelting, but finding the demand increase, he raised his prices so much as to place us in an awkward position. Believing that I had limestone in my own lands which adjoined this quarry, we commenced boring, and soon found the limestone at no great depth. Our neighbour then became amenable to reason, and my limestone was no longer needed, but being down at the limestone we thought we might as well bore a little farther. However, a kind friend one fine night dropped the boring chisel point upwards into the hole, and we were stopped. There is always some reason for every thing, and not knowing I had any enemies, it occurred to me that it was, perhaps, some iron ore raiser who did not wish his trade to be interfered with like our lime customer, so I determined to renew my boring, but, instead of going 10 fathoms to the limestone, I preferred coming to what I thought might be the outcrop of the lime and boring there. I did so, and at 7 fathoms came not on limestone, but on ore without any rock cover. This was at variance with the accepted theory that hematite iron ore was confined to the limestone, and this theory having been once found wrong, it caused me to doubt its general accuracy, and I have since found that hematite iron ores do not, as a rule, confine themselves to any particular rocks, but are found sometimes without any rock cover at all, as in my case. Sometimes in limestone fissures, as frequently in the Cleator district; sometimes in slate fissures, as at Knockmurton; sometimes in granite, as in Eskdale; sometimes in what we call whirlstone, but very frequently between two different rocks, *i.e.*, slate rock on one side and limestone on the other, as at Lindale Moor and Park Mines in Furness—whirlstone on one side and limestone on the other—sandstone on one side and limestone on the other, as at Lord Leconfield's Big Rigg mines; and sometimes in a fissure in trap, as at Hading, so that it can be said to belong to no particular rock, which is the first fact I have noted. The second fact which presented itself to my notice was that the hematite iron ore formation must have some relation to the coal fields, for as the development of the iron ore mines proceeded, we found that the chimnies of the iron ore pits took the outer range of the coal pit chimnies. By outer range I mean a line further from the sea than the coal, but nearer to the mountain range and the outcrop of the metals. This fact, however, was quite at variance with the hematite iron ore field in the Ulverstone district where there never was a trace of coal.

However, some years after, Mr. Kennedy, of Ulverstone, boring near the entrance to the Duddon estuary, came on what he called drift-coal lying in the running sand. Small though these pieces of coal were, they gave their voice in favour of the vicinity of the coal formations; and this has now distinctly and unmistakably announced itself by the exploration at Sturch, near Barrow, to the south of the previous workings, where Mr. Wadham, as mineral agent for the Duke of Buccleuch, has just opened out and taken to a depth of 97 fathoms a pit commenced nearly 200 years ago as a coal-pit, and which Mr. Wadham continued to deepen *as a coal-pit* till he came to a mass of hematite iron ore worthy of his perseverance. A section is on the wall, kindly provided by him, and will be explained by him.

In addition to this, you will find a section of the Montreal Iron Ore pit in the Cleator district, provided by another kind friend, Mr. Turner, passing through coal strata, and at last developing itself in hematite. This confirms my second fact, that all large hematite deposits are associated with a coal-field.

The third fact which we have chronicled in the Whitehaven and Ulverstone fields is, that these hematite deposits seem to run from north-west to south-east, as if they had some relation to the magnetic current. You will observe, on the index behind me, the red line denoting magnetic north and south,—and I will put upon it by the black pointer the direction of the hematite deposits in the Ulverstone, the Whitehaven, and the Haddington districts, and you will find that they have all a persistent tendency to take a north-west and south-east direction. To such an extent is this fact accepted in the Whitehaven district, that, whenever a deposit is struck in one property, the owners of adjacent royalties bore upon the well-known direction. Mr. Roper, a most valued correspondent, speaking of the Ulverstone district, says that if you take an ordnance map, and start from the line of their open workings (those of Messrs. Harrison, Ainslie, and Co., of Lindale Moor), you may, with a parallel ruler, get the line of every other vein in the district.

There is yet another point bearing on the magnetic correlation. I found, in testing borings, that what the magnifying glass did not reveal the blade of a knife would, and many times, when it was difficult to decide, even from the specific gravity, whether there was iron ore in the borings or not. The magnetised blade of a knife would do it; for it would attract particles of iron from the mass, just as a magnet attracts the iron filings from a mixture of brass and iron filings. Now I leave this matter in the hands of the electricians. We know a little,—but very

little,—of the magnetic current; we know it is constant,—that electricity applied to the magnet intensifies its power almost incalculably. Can this constant magnetic current weaken or dislocate the rocks in its course, and thus prepare a channel for any hematite deposit which may take place from the coal-fields? There is an affinity, but I am not prepared to say which is cause and which effect.

The fourth fact is the almost total want of carbonic acid in hematite deposits, and the vast amount of carbonic acid in the iron-stone deposits in coal-mines. This, I leave to the chemists. On the table you will see an extract from the *Memoirs of the Geological Survey of Great Britain*, and you will there find that, while the hematites give no certain return of carbonic acid, the iron-stones in all the coal-measures hold it in large quantities. The question naturally arises,—Can the chemist, by his art, reduce the iron deposit of the coal-measures to a hematite, and how would he do it? Having obtained a hematite, could he *resolve* it?

The fifth fact is that I know of no hematite deposit of any size or magnitude which is not bordering on a coal-field, and that coal-field at its dip under the influence of water. I refer you to the maps on the wall, and ask you to notice how the Furness district, the Whitehaven district, and the Haddington district have all that singular characteristic. I merely give it for what it is worth, but it is a fact. The Bristol field I have not examined myself, and therefore I say nothing of it, but I believe it has the same conformation; and I am told the hematite lodes have the same direction—south-east and north-west; but, as I do not know of my own knowledge, I say nothing about it.

There is, perhaps, one other circumstance attending the Ulverstone and Whitehaven fields which I ought to name, as otherwise, confusion may arise when we speak of hematite iron ores. The trade in general, the raisers as well as users of ore, speak of two kinds of hematite, rock, or blast ore, and smil, or puddle ore. The first is got with steel jumpers, double-handed hammers, and gunpowder; the second, or soft ore, with picks and shovels. Now, to all appearance, this latter ore is deposited by filtration, and the former has not this. The mines in Furness, until recently, were all of the former character. On the table, you will find a specimen of the soil from a field near Furness Abbey; and it is a fact that iron ore is re-deposited by filtration after the lapse of a few years.

Iron-Stones.

(From the *Memoirs of the Geological Survey*.)

District.	Analyst.	Carbonic Acid.
Weardale, Durham, (east line) ..	J. Spiller	*14·49
Ditto, ditto (Rispry) ..	A. Dick	†37·71
Black Bed, Low Moor, Yorkshire ..	J. Spiller	26·57
Thorncliffe, Black Mine, Parkgate	,,	31·39
Thorncliffe, White Mine, Parkgate	,,	29·38
Black Mine, Parkgate	,,	28·47
Swallow-wood Rale, Staunton, Derbyshire	,,	28·64
Brown Rale, Butterley, Derbyshire	,,	29·92
Ditto ditto ditto ..	,,	26·74
Black Rale, Butterley, Derbyshire	,,	25·63
Dog-Tooth Rale, Staveley, Derbyshire	,,	37·61
Henry Croft Rale, Stanton, Derbyshire	,,	29·72
Civilly Rale, Stanton, Derbyshire ..	,,	29·83
Dale Moor, Stanton, Derbyshire ..	,,	28·63
Cleveland, Yorkshire	A. Dick	22·85
Brooch Ironstone, Congreave, Stafford	J. Spiller	28·22
Pins, Dudley	A. Dick	30·21
Penry Earth, Dudley	,,	25·92
Grains, Dudley	,,	35·25
Gubbin Iron-stone, Dudley	,,	30·44
Ditto ditto Cannock, Dudley	,,	31·02
Ditto ditto Rubble, Dudley	,,	26·53

* Lowest. † Highest.

District.	Analyst.	Carbonic Acid.
White Stone Bind, Dudley	J. Spiller	22·13
Bottom Stone Bind, Dudley	,,	32·16
White Stone Rough Hey Colliery, Darlaston	C. Tookey	26·89
Cakes, or Blue Stone, Darlaston ..	A. Dick	35·47
Ditto ditto ditto ditto ..	,,	34·00
Fire Clay Balls, Darlaston	,,	30·00
Ditto ditto ditto	,,	30·96
Poor Robins', Bunker Hill	,,	33·05
Rory Hill, White Stone, Darlaston	,,	29·03
Ditto ditto, ditto Bad, Darlaston ..	,,	20·94
Ditto ditto, ditto, Rough Hey Colliery, Darlaston	C. Tookey.	30·08
Gubbin and Balls, Bunkers Hill ..	A. Dick	28·08
Ditto ditto ditto ditto ..	,,	32·31
Ditto ditto Rough Hey Colliery	C. Tookey.	30·80
Ditto ditto Gib Colliery ..	,,	32·05
Blue Flatts, Gib Colliery	,,	30·91
Silver Threads, Gib Colliery	,,	33·35
Diamonds, Gib Colliery	,,	29·13
Ditto ditto ditto	A. Dick	31·94
Brown Stone, Bloxaril	,,	32·04
	42—1240·49	
Average		29·52

Thomas Ainsworth, August 2, 1871.

Hematite Ores.

(The first four from the *Memoirs of the Geological Survey*, the last ten from private sources.)

District.	Analyst.	Carbonic Acid.
Cleator Moor	A. Dick	none.
Ditto ditto	,,	none.
Gillbrow, Ulverstone	,,	2·96
Lindale Moor, Ulverstone ..	J. Spiller	none.
Knockmurton	Professor Penny	none.
Ditto	,,	,,
Ditto	,,	,,
Cleator Iron Ore Co.	,,	*3·35
Ditto ditto ditto	,,	none.
Ditto ditto ditto	,,	3·35
Ditto ditto ditto ..	Pattison Newcastle Co.	none.
Ditto ditto ditto	,,	,,
Ditto ditto ditto	,,	†1·32
Sneletor, Haddington ..	D. S. McAdam, Edinbro'.	none.
	14—10·98	
Average		0·78

Thomas Ainsworth, August 2, 1871.

ON J. STODDART'S PLAN OF CONCENTRATING SULPHURIC ACID: REPLY TO F. BODE.

By JOHN GALLETLY.

While engaged on some work for Mr. Young, at Bathgate, now fully two years ago, the idea of concentrating vitriol with the aid of a current of air in lead vessels suggested itself to me, and I made some experiments on the subject, which, being done entirely independent of those of Mr. Stoddart, a short account of my results may be interesting, in addition to any facts Mr. Stoddart may communicate.

I repeatedly concentrated a gallon of brown vitriol in a small lead box, the depth of the liquid being 4 or 5 inches,

* Highest. † Lowest.

and the temperature varying from 190° C. to 200° C., till the specific gravity was about 1·840. In these experiments I chiefly examined the lead box, and compared the appearance of the precipitate of sulphate of lead which this vitriol gave on dilution with water, with that from the same vitriol concentrated in glass bottles, and felt satisfied that the action on the lead was but slight, and would not be a practical difficulty with vitriol made from sulphur, although it might be with pyrites vitriol.

I have, however, a note of one experiment more definite. I used a lead box, 18 inches long by 12 inches broad, and had a lead shelf burnt in it, the full breadth and nearly the whole length of the box, at such a height that, when just covered, the box held 5 gallons. Below this shelf a lead pipe with small holes in it was introduced, though which air was forced, which passed along under the shelf and about an inch from the surface of the vitriol; it was the same arrangement that Mr. Young employed for saturating his solutions with chlorine in the manufacture of chlorate of potassa. In this apparatus I prepared from brown vitriol (1·745 sp. gr.) 5 gallons of vitriol, of 1·830 sp. gr., by keeping the temperature at 205° C. for one hour, and forcing 16½ cubic feet of air through the liquid. The loss of monohydrated sulphuric acid was 11·19 per cent, as as against 8·8 per cent, which I found to be the loss by concentrating in the ordinary glass bottles; this, however, could be recovered by passing the air into the chambers or through a condenser. The quantity of air used in this case will appear small; it was only roughly measured by blowing air through the same lead pipe into a gas-holder in as nearly the same manner as possible, but, having a note that 24,000 cubic feet of gas was forced into a gas-holder by fanners, against a pressure of 5 to 6 inches of water, with the expenditure of 1 ton of coals, it did not appear necessary for my purpose to be more exact.

The water that came away at first contained practically no vitriol; the last fourth had a sp. gr. of 1·070. The object of my experiments was chiefly to effect the concentration of vitriol to about 1·840 sp. gr. in lead vessels at a temperature not higher than is usually reached in making brown vitriol (1·745 sp. gr.). I felt satisfied that the dissolving of the lead pans by the ordinary method of concentration was due much more to the increase of temperature required to expel the water from brown acid than to the action of the stronger acid on the lead, and my experiments confirmed me in this belief. I have not since, however, had an opportunity of carrying out this process on a working scale, although it has been the intention to do so at Addiewell for some months past. I have no doubt of the process succeeding, but must add that Mr. Napier, of Glasgow, aware of my results, did commence to give it a trial some time last year, without at once getting it to succeed. I understand his box did not keep its shape, a difficulty that could be easily avoided, but I have not heard that he has renewed the experiment.

Theoretical calculations of the advantages of this plan of concentrating vitriol, though not to be neglected, can only be wide approximations to working results. So much heat from even the best built pans passes into the flues that there is ample to spare for superheating the air and propelling a small engine for blowing it through the vitriol. Again, if the water can be evaporated at a heat lower by 80° C. by using a current of air than without it, the extra heat, communicated to the vitriol in consequence from the furnace, will be very considerable, but varying with each construction of furnace. Then, in the case of the concentrated acid, the heat would be communicated by direct contact with the lead vessel, whereas, in the ordinary glass bottle, it is radiated to the vitriol from the hot sides of an iron pot. The labour of filling and emptying so many bottles with syphons, and attending to so many fires, would also be avoided. It seems to me as if concentrated acid might almost be sold at about the present price of brown, allowing for the difference in strength.

Addiewell Chemical Works,
August 24, 1871.

NOTICES OF BOOKS.

The Elements of Plane and Solid Geometry. By H. W. Watson, M.A., sometime Fellow of Trinity College, Cambridge, late Assistant-Master of Harrow School. London: Longmans, Green, and Co. 1871.

In this, the sixth of a series of scientific handbooks published by Messrs. Longmans, Mr. Watson opens up new ground for the student of geometry, and, by an original method of treatment, makes Euclid much more comprehensible. The syllogistic form of enunciation has been retained, but with an extension of the principle of superposition, whereby much unnecessary reasoning has been dispensed with. The work is certainly to be highly commended to the student's notice.

Useful Chemical Tables, arranged for the Use of Teachers and Students. Oxides, Sulphides, and Chlorides, with Blank Forms for adaptation to other Compounds. By Adolphus Collenette, Teacher of Chemistry, Elizabeth College, Guernsey. Guernsey: F. Clarke. 1871.

These tables will be useful not only to students, but also to teachers of chemistry; they are intended—(1). To give a tabular view of the principal binary compounds of the elements with O, S, and Cl; (2) to give, at a glance, the number of compounds of any element with the metalloids just mentioned, and the number of oxides, sulphides, or chlorides having one formula. By means of the blank forms, the following compounds may be tabulated:—Iodides, bromides, fluorides, oxychlorides, oxybromides, oxyiodides, acids, &c. The author has adopted two methods of classification, viz.—(*a*) Quantivalence: the elements being classified under the heads Monads, Dyads, Triads, &c.; (*b*) Metalloids and Metals: the former are printed in red type, the latter in black, while thick type is employed for common metals and italics for rare. We have great pleasure in recommending this volume to all who are interested in having the study of chemistry simplified and methodically treated, as well as to chemists generally, not only as tables of easy reference for existing compounds, but also to register new discoveries. The typographical execution of these tables is highly creditable to the press of the Channel Islands.

MISCELLANEOUS.

An American View of Patent Laws.—The Hon. Charles Mason, an eminent Ex-Commissioner of Patents, has written to Mr. G. Haseltine, M.A., Chairman of the Meeting which passed the Resolutions on "Patent Law Reform," reported by us July 7th, an instructive letter on the subject, an abstract of which we append:—I have, he says, never had any serious doubt of the wisdom of a judicious system of patent laws. The public welfare is best promoted by inspiring individual effort in respect to invention, through the motive of private gain; and who can more justly claim the exclusive use of any property than he who has brought it into being?—The American system of examination is productive of much advantage to inventors and the public, but I doubt the wisdom of lodging in officials an unlimited power of rejection. If the duties of examiners were advisory and adjuvant, reserving to an applicant the ultimate right to a patent, at his own risk, the chief objection to this system would be removed. The fees by all means should be small—barely sufficient to defray the expenses of the patent office. Inventors are benefactors, and, as a class, poorly compensated for their labour. The imposition of large fees discourages invention, and thereby checks the progress of civilisation. This cannot be sound policy. Experience leads me to the conclusion, that patents should be granted for more than fourteen years, but this term, in most cases

of merit, is extended by our office to twenty-one, and often by Congress to twenty-eight years. The new law limits the term of a patent to seventeen years, which will, no doubt, hereafter be extended; and I do not think twenty-one years too long a period for the original grant. In one respect I like your system better than ours—your fees are paid in instalments, giving the patentee the option of keeping his patent alive. The French plan of annuities is carrying the matter rather too far. I think the English system better than the French or the American, and all that is needed is a reduced rate of fees. Experts are often very useful, but they are regarded with suspicion, and their opinions have little weight in our courts, therefore, what might be a great evil, carries in some measure its own remedy, and the interposition of jurors in patent suits is generally avoided by obtaining injunctions in chancery, which is our usual remedy for infringements.

Prosser's Spreading Fire Nozzle.—There is no greater enemy to life and property than fire, and although of late years the subject of fire-engines has received great attention from practical men, yet there is great room for improvement in detail. We have therefore great pleasure in calling the attention of manufacturers, warehousemen, mill-owners, railway companies, ship-owners, theatrical managers, &c., to "Prosser's Adjustible Spreading Nozzle." Yesterday evening we were invited to see this nozzle tried in practice, Mr. Holland, proprietor of the North Woolwich Gardens, having previously made arrangements for the attendance, with their engines, of three of the London Volunteer Fire Brigades—namely, the Wood Green, Pentonville, and the Ferdinand Volunteer engine from Camden Town, the whole under the superintendence of Mr. Reiney. Mr. Prosser welcomed the opportunity of showing the public what his nozzle could do; before being fitted on to the ordinary branch pipe of a fire hose, the structure was explained to us. It consists of a nozzle fitted with a number of movable and an equal number of fixed fingers. The movable fingers may be brought into the stream issuing from the jet, thus dividing the solid stream into a more or less fine spray. This is done by a simple turn of the wrist. The result of this ingenious mechanism is that the stream of water can be cut up into a spray more or less fine: thus at one time there were playing from the nozzle eight of the adjustible fingers, at another time ten, at another time four, the stream being finally varied from one resembling in its intensity a thunder shower to the ordinary spray of a shower bath. A wooden house had been built at one end of the North Woolwich Gardens, and between the walls were piled tar-barrels, timber, and other inflammable materials; shortly after a light had been applied the whole place was in flames; a signal was then given to the fire-engines to play upon them. Standing close to the fireman who had the working of Mr. Prosser's patent nozzle, we were enabled to watch its action narrowly. A stream of water first issued from it as from the nozzle of an ordinary fire-engine. The fireman then, by a slight turn of the wrist, altered the form of the jet at will according to the force of water he wished to bear on the fire. The conclusion that we have arrived at is, that Prosser's spreading nozzle is a valuable adjunct to the present known means of extinguishing fires, for by setting the internal mechanism at work the fireman is enabled to approach the flames when at their fiercest; as they gradually subside so he alters the form of his jet. In close quarters a good blaze has no chance whatever against the nozzle, for the water is spread out into a large shower of heavy rain in a conical form, or the jet may be so adjusted as to rush out like a vapoury tail of a comet. The water being thus thoroughly subdivided is formed into spray, every drop of which coming into contact with the heated materials, is immediately converted into vapour, against which the flames can no longer hold their own. It is at the commencement of a fire that assistance is most needed, quickness of action in extinguishing the origin of the fire being all essential. We therefore recommend all those who have already either engines or hose fitted, to procure one of these spreading nozzles, which we understand are adaptable to any branch as at present fitted, as they appear calculated to become the means of preventing the loss of much valuable property.—*Land and Water.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, August 7, 1871.

The original papers and memoirs met with in this number and relating to chemistry and collateral sciences are the following:—

Production, by Artificial Means, of the Calcareous Matter such as is met with in the Animal Organism.—M. Harting.—This paper is a preliminary communication on the subject alluded to, which may be termed a first attempt at synthetical morphology. It appears that the author has obtained results of great importance, which will be communicated at a future day in full, accompanied by engravings of the specimens, some of which have been sent to the Academy.

New Book on Applied Geology.—E. de Beaumont.—As one of the perpetual secretaries, the *savant* just named calls the special attention of the meeting to "Leçons Elémentaires de Géologie Appliquée à l'Agriculture," by M. Meugy.

Spectra of the Simple Gases.—A. J. Angström.—A lengthy monograph on this subject.

Calorific Phenomena which accompany the Conversion of Hyponitric into Nitric Acid, and on the Introduction of these Two Acids into Organic Substances.—L. Troost and P. Hautefeuille.—The contents of this paper bear upon calorimetry, and cannot be usefully abstracted without the reproduction of lengthy series of tabulated results of experiments.

Accidental Kindling of a Gas Burner by Lightning.—W. de Fonvielle.—During a thunderstorm at Paris on the 3rd of August last it appears that a building in the Rue Leclercq was struck by lightning, and that the gas of a gas burner placed close to a wall and near to a metal water-spout, was ignited by the electric spark.

This number also contains several papers relating to meteorology and geology.

Le Moniteur des Produits Chimiques pour l'Industrie, les Sciences et les Arts et du Matériel de ces Industrie Publié par une Société de Chimistes et d'Industriels, Nos. 1 and 2, 1870.

This periodical, published at Paris, made its first appearance just before the war broke out last year. Only two numbers appeared then, but the publishing having been now resumed, we shall be enabled to communicate to our readers any useful or interesting original matter which may be met with in the pages, of which the full title is given above. This paper appears on the 10th and 25th of each month.

No. 3, July 10, 1871.

This number contains the following original papers and memoirs:—

Sucrate of Hydrocarbonate of Lime applied to the Refining of Cane Sugar.—MM. Boivin, Loiseau, and Co.—This lengthy memoir is divided into the following sections:—Production of the lime and carbonic acid; slaking of the lime; preparation of the saccharo-calcic solution; formation of the sucrate of hydrocarbonate of lime; utilisation of the sucrate of hydrocarbonate of lime; filtration of the purified liquor; saturation of the filtered and purified liquor; boiling of the saturated liquor; filtration of the liquor after boiling; washing the residues; the chief advantages of the process of the sucrate of hydrocarbonate of lime. The contents of this paper bear essentially upon the practical application of the process alluded to.

Soap Manufacturing Industry of Italy.—E. Rousset.—Contains a few historical and interesting statistical matters on this subject.

Ancient Brevets d'Invention.—Under this title it is proposed to re-publish some of the more important *brevets d'invention* of old date. Very properly, the series is opened by a brevet granted for fifteen years to Nicholas Le Blanc, on September 15th, 1791, for the extraction of soda from common salt on the large scale.

Utilisation of Waste Leather Cuttings which contain Grease.—M. Picard.—During certain processes of the operations known as tawing and currying, leather is impregnated with fatty substances. The waste cuttings are submitted by the author, first to ebullition in water, and next, after decantation of the water, to strong pressure by means of an hydraulic press; the greasy matters are thus cheaply and readily recovered, and may be used for various purposes.

No. 4, July 25, 1871.

The original papers contained in this number are—

Chemical Products of Italy.—E. Rousset.—This paper treats on the following subjects:—Production of acids (viz., sulphuric, nitric, hydrochloric, citric, and boric), alkalies, and salts, including the gunpowder industry in the kingdom of Italy.

Soap Manufacturing Industry at Marseilles.—E. Rousset.—The ancient city just named has sixty-two soap-works, producing, on an average, annually 70,000,000 kilos. (70,000 tons) of hard soap made of olive oil. Although the bulk of this quantity is used in France, a greatly increasing export trade of this article is here spoken of.

New Method of Preparing Borax.—M. Jean.—When an alkaline sulphuret, boric acid, and water are put together, the fluid just named is decomposed; its oxygen combines with the metal, which, as oxide, combines with the boric acid, while sulphuretted hydrogen is set free. This reaction is elucidated by the following formula:—$SM+2BoO_3+HO=SH+2BoO_3MO$. The author carries on his process by first preparing sulphuret of sodium from sulphate of soda, which is thrown into a vertically-placed fire-clay retort filled with coke and previously heated to redness. The carbon reduces the sulphate of soda into sulphuret, which runs off at the bottom of the retort (the coke resting on a perforated slab of fire-clay). The sulphuret thus obtained is broken into small lumps, and, having been placed in a stout linen bag, is, along with the boric acid (also contained in a linen bag), suspended in the higher portion of a cylindrically-shaped tank filled with cold water. That tank is fitted with an air-tight cover, wherein a pipe is fixed to carry off the sulphuretted hydrogen.

Obituary.—Under this head we learn that the well-known Dr. Boucherie died lately at Bordeaux; the deceased was widely known by his investigations on the preservation of wood and timber, and was in early life one of the first who manufactured beet-root sugar in France on the large scale. Prof. Fritzche, of St. Petersburg, died on the 8th ult., at Dresden; the deceased occupied a prominent place among the *savants* of the Imperial Russian Academy of Sciences, and as the discoverer of aniline, not only science, but modern industrial chemistry, owes very much to him. It would be next to impossible to quote here, even briefly, the large number of the deceased's scientific labour.

No. 5, August 10, 1871.

The original papers contained in this number do not bear upon chemistry directly, and are only of local interest.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, No. 210, June, 1870.

This number does not contain any original papers relating to chemistry and allied sciences.

Nos. 211 and 212, July and August (double number), 1870.

The contents of this number are entirely devoted to the publication of the proceedings of the general annual meeting of this Society, the distribution of prizes and medals, and the reports of various committees on divers subjects. The only paper more directly bearing upon chemistry is—

Report on the Prize Essay concerning the Utilisation of Manufacturing Residues.—Prof. Balard.—From this lengthy memoir, not well suited for any useful abstraction, it appears that the best essay on the subject alluded to was sent in by P. Buquet and W. Hofmann—the former manager, the latter chemist to the chemical works at Dieuze. The essay alluded to will be published by this Society.

Nos. 213 and 214, September and October (double number), 1870.

The only original paper met with in this number, and indirectly bearing upon chemistry, is—

Eulogium on Theophile Jules Pelouze.—M. Dumas.—However valuable the contents of this very lengthy scientific biography are, they are not suited for any useful abstraction here.

Nos. 215 and 216, November and December (double number), 1870.

The only original paper relating to chemistry contained in this number is—

Report on P. Thomas's Gas Burner.—M. Debray.—This lengthy paper is accompanied by several woodcuts illustrating a contrivance by means of which it is possible to obtain at pleasure, with the gas burner alluded to, either a far lower or very greatly increased temperature than is possible with the Bunsen burner.

Annalen der Chemie und Pharmacie, July, 1871.

The following original papers are contained in this number:—

Researches on the Constitution of the Doubly-Substituted Benzols.—E. Ador and V. Meyer.—The fourth and concluding instalment of a monograph on this subject, containing the following sections:—Sulphanilic acid; benzol-sulpho acid from sulphanilic acid; brom-benzoic acid and isophthalic acid; general review and appendix.

Gallic Acid Ethers.—F. Ernst and C. Zwenger.—This essay treats on the ethers which gallic acid forms, and may be prepared by first dissolving that acid in the respective absolute alcohol, and next passing through that solution, heated to the boiling-point, dry hydrochloric acid gas. The purification of these ethers is rather a tedious process. Gallic acid ethyl-ether—

$$C_6H_2\left\{\begin{matrix}(OH)_2\\CO.O(C_2H_5)\end{matrix}\right\}+2\tfrac{1}{2}HO$$

is a solid substance, soluble in warm water, crystalline, readily soluble in alcohol and ether. These solutions exhibit an acid reaction. This ether fuses at 150°, but at 90° if rapidly heated; it melts in its water of crystallisation. The gallic acid methyl-ether closely corresponds, in its properties, with the foregoing. The gallic acid amyl-ether—

$$C_6H_2\left\{\begin{matrix}(OH)_2\\CO.O(C_5H_{11})\end{matrix}\right.$$

is a solid crystalline substance, contains no water of crystallisation, fuses at 139°, difficultly soluble even in warm water, but readily so in alcohol, ether, and chloroform, which latter does not dissolve gallic acid. All these ethers act as acids, decompose alkaline carbonates, and yield, with proto-salts of iron, a violet colouration, which becomes blue by exposure to air. With the per-salts of iron a deep blue colouration is produced, while these ethers reduce nitrate of silver and chloride of gold at the ordinary temperature.

Researches on some of the Substances Crystallised in Fused Beads of Phosphor Salt and Borax.—A. Knop.—The continuation of the exhaustive monograph on this subject contains the following sections:—Crystallisations from phosphor salt; crystallisations from borax.

Normal Valerianic Acid.—A. Lieben and A. Rossi.—The acid alluded to is obtained by boiling normal cyanbutyl with alcoholic caustic potassa solution. The purified acid, $C_5H_{10}O_2$, exhibits an odour more akin to that of pure butyric acid than to that of the ordinary valerianic acid. The normal valerianic acid is a liquid which, even at −16°, is not congealed; it boils at 185°; its sp. gr. at 0° is 0·957. 1 c.c. of this acid requires for its solution 27 c.c. of water. The authors describe a series of the salts of this acid.

Researches on the Allyl Group. Seventh chapter: Conversion of Allylic Alcohol into Propylic Alcohol.—B. Tollens—And on—

Allyl-Cyanide, or Crotonitrile—A. Rinne and B. Tollens—And—

Oxidation of Allylic Alcohol—A. Rinne and B. Tollens—Are portions of the lengthy monograph on the allyl group. However valuable and interesting in a scientific point of view, this work is not suited for any useful abstraction.

Alleged Bibasicity of Gluconic and Lactonic Acids.—R. Fittig.—A reply to Prof. Hlasiwetz's paper (see CHEMICAL NEWS, vol. xxiii., p. 287) on this subject.

Action of Sulphurous Acid upon Platinum-Chloride.—(Second paper.)—K. Birnbaum.—After briefly referring to his former paper on this subject (see CHEMICAL NEWS, vol. xx., pp. 189 and 322), the author, in this portion of his essay, describes a series of salts obtained by the action of sulphurous acid upon platinum-sal-ammoniac. The soda salt may be obtained in orange-coloured, silky, shining, needle-shaped crystals; formula—

$$Pt\left\{\begin{matrix}Cl\\NaSO_3\end{matrix}\right\}+2NH_4Cl+H_2O.$$

The lime and magnesia salts are too deliquescent to be obtained in crystalline state. The baryta salt, $3Pt,2Ba,6NH_4,3SO_3,10Cl,3H_2O$, or—

$$Pt\begin{matrix}<Cl\\<SO_3\\<SO_3\\<SO_3\\<Cl\end{matrix}>Ba+BaCl_2+6NH_4Cl+3H_2O,$$

is a crystalline body. The paper further refers to the potassa salt, and a series of double salts belonging to this group.

Temperature of Decomposition of Sulphuretted Hydrogen.—J. Myers.—From the author's experiments it appears that sulphuretted hydrogen is decomposed at between 350° and 400°.

Sulphuretted Hydrogen Contaminated with Arseniuretted Hydrogen.—J. Myers.—At the ordinary temperature the two gases alluded to can co-exist without decomposition, which only takes place at the boiling-point of mercury according to the formula—

$$3H_2S+2AsH_3=As_2S_3+12H.$$

The author, while experimenting, thought that the arseniuretted hydrogen might be due to the presence of some arsenic in the sulphuret of iron employed, but, on investigation, it turned out that the source of the arsenic was in the commercial sulphuric acid used for the evolution of the sulphuretted hydrogen.

Journal für Gasbeleuchtung und Wasserversorgung, No. 14, 1871.

The original papers in this number bear strictly on matters relating to gas- and water-works' engineering and management.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, May, 1871.

This number does not contain any original papers bearing upon chemistry, but we meet here with an essay on the—

Velocity of the Progress of Electro-Dynamical Action.—Dr. Helmholtz.—The author found that the velocity alluded to exceeds 314,400 metres (about 195 English statute miles) in one second of time,

Les Mondes, August 17, 1871.

This number contains the following original matter relating to physico-chemical sciences:—

Studies on the Geology, Meteorology, and Archæology of Constantine (Algeria).—M. Tissot.

Sound Produced by Discontinuous Vibrations, more especially those obtained by means of the Siren.—M. Terquem.—The contents of this paper bear strictly upon acoustics.

This number contains a series of papers bearing upon hygiene, and, among these, one on drunkenness among the French soldiers as a cause of the late disasters.

Pharmaceutische Zeitschrift für Russland, No. 6, 1871.

This number does not contain any original papers relating to chemistry.

No. 7, 1871.

The original papers and memoirs relating to chemistry and allied sciences in this number are—

Experiments made to Ascertain the Alleged Poisonous Nature of certain kinds of Fish.—Dr. A. Casselmann.—The contents of this paper bear upon some experiments made upon cats to which was given some fish (properly cooked), which, on being partaken of as food, had caused, in some thirty-five cases, symptoms of a peculiar kind of poisoning. The fish was, however, not quite fresh, but being partly cured with salt, and kept at the winter temperature of St. Petersburg, was not at all in a decayed state. The nature of the poison was not discovered, neither were the cats at all affected by the fish given to them, which, in this instance, belonged to the sturgeon tribe. It is a well-known fact that fish may become poisonous under conditions as yet entirely unknown.

Means to Distinguish Benzol from Benzine.—J. Brandberg.—Pitch is stated by the author to be dissolved readily and completely by benzol prepared from coal-tar, whereas benzine, also known as ligroine or petroleum spirit, hardly dissolves the substance alluded to at all.

No. 8, 1871.

The only original paper in this number is the pharmacognostic essay on the—

Gum and Gum-Resin producing Plants which are met with in the Steppe district of Central Asia.—Dr. R. Palm.

No. 9, 1871.

Does not contain any original papers relating to chemistry.

No. 10, 1871.

The only original paper relating to chemistry is on the—

Freezing of Aqueous Solutions of Salts.—Dr. G. C. Wittstein.—The author placed (at St. Petersburg) the undermentioned solutions of salts, prepared in larger quantity and kept in stoppered bottles, in a store-room, the temperature of which was for several consecutive weeks below 0°, but never below −6°. The saline solutions which remained unfrozen were—Ammonium chloride (1-5), antimoniate of potassa (1 of the granular salt to 240), hydrate of baryta (1-19), barium chloride (1-9), calcium chloride (1-9), acetate of baryta (1-9), neutral acetate of lead (1-9), basic acetate of lead (1-9), ferrocyanide of potassium (1-9), ferricyanide of potassium (1-9), iodide of potassium (1-9), sulphocyanide of potassium (1-9), hydro-fluosilicic acid (1-16), carbonate of ammonia (1-9), carbonate of potassa (1-9), carbonate of soda (1 cryst. salt to 6), molybdate of ammonia (1-19), oxalate of ammonia (1-29), bichloride of mercury (1-19), nitrate of baryta (1-19), nitrate of lead (1-9), proto-nitrate of mercury (1-19), proto-sulphate of iron (1-4), sulphate of potassa (1-14), sulphate of magnesia (1-9), tartaric acid (1-4), protochloride of tin (1-9). The following solutions were frozen:—Oxalic acid (1-9), phosphate of soda (1-14), nitrate of silver (1-49), and sulphate of lime (1-400). The figures between parentheses indicate the proportion of the salts to that of water.

No. 11, 1871.

The only original paper relating to chemistry is an essay on—

Aluminium Chlorhydrate (so-called Chloralum), and on some other Alumina Compounds.—Dr. E. Thorey.

Journal für Praktische Chemie, No. 10, 1871.

This number contains the following original papers and memoirs:—

Synthesis of Normal Propylic Alcohol, Ethyl-Alcohol being taken as the starting-point.—A. Rossi.—The author first prepared cyanethyl, converted that into propionate of lime, and, by distilling that along with formiate of lime, obtained the aldehyde of the propionic acid, which, being treated with sodium amalgam, became converted into propylic alcohol. That alcohol is a colourless, mobile fluid, soluble in water in all proportions, and boiling at 96°; sp. gr. at 0°, 0·8205; formula, C_3H_8O. The author further describes some of the haloid combinations of propyl obtained from the alcohol alluded to.

Mineralogico-Chemical Researches.—Von Kobell.—This paper treats on the following subjects:—Monzonite, a new mineral species.—The mineral here alluded to was found on the Monzoni mountains, in the Fassathal (Tyrol). The colour of the mineral is light greyish-green; it is hard and compact, rather readily fusible before the blowpipe, sp. gr. = 3·0, and soluble in concentrated phosphoric acid. The composition of the mineral, in 100 parts, was found to be the following:—Silica, 52·60; alumina, 17·10; protoxide of iron, 9·0; lime, 9·65; magnesia, 2·10; soda, 6·60; potassa, 1·90; water, 1·50;—total, 100·40. Marcellin consists, in 100 parts, of—Oxide of manganese, 66·68; oxide of iron, 10·04; protoxide of manganese, 8·79; protoxide of iron, 1·30; lime, 1·14; magnesia, 0·26; silica, 10·24. Behaviour of sulphuret of bismuth with iodide of potassium before the blowpipe (bismuthite from St. José, in Brazil).—When iodide of potassium is mixed with sulphuret of bismuth, and ignited upon charcoal before the blowpipe, the coal is coated with a beautiful deep red-coloured film of iodide of bismuth. Pure metallic bismuth does not, under the same conditions, give this reaction; but, when the metal is rubbed along with some sulphur, and then ignited, as just alluded to, the same phenomenon is observed, but gradually the red colour fades and the film becomes yellow. Bismuthite, of a peculiar grass-green colour, and structure akin to green pyromorphite, was found by the author among some Brazilian minerals. On mixing this mineral (carbonate of bismuth) with iodide of potassium and sulphur, and igniting it before the blowpipe, it gave also the reaction above alluded to, which is highly characteristic for bismuth.

Observations made while Analysing various samples of Commercial Tin.—Dr. T. Scheerer.—The author chiefly points out the variable composition of some of the sulphurets of tin, and communicates an analysis of meta-sulphuret of tin dried over sulphuric acid, and found to consist, in 100 parts, of—Tin, 54·14; sulphur, 29·36; water, 16·50. Formula, SnS_2+2HO. The same substance, dried at 140°—Tin, 59·0; sulphur, 32·0; water, 9·0. Formula, SnS_2+HO.

New Method of Separating Magnesia from Potassa and Soda.—Dr. T. Scheerer.—Reserved for full translation.

Rosolic Acid.—H. Fresenius.—The contents of this paper, although valuable, are not suited for any useful abstraction.

NOTES AND QUERIES.

Diamond Dust.—(Reply to Josiah Lowe.)—By digesting the dust along with hydrofluoric acid, as commercially sold, in either leaden or platinum vessels, you will be able to dissolve the glass, leaving the diamond-dust unattacked.

Skein Silk.—C. R. Stevens will find that silicate of soda will decompose muriate of tin without the aid of heat. It may be used very much diluted, and does not injure cotton or wool. He will find, by experiment, the strength most suitable for silk.—T. F.

Schlo-Liao.—(Reply to E. J. L.)—Among the constituents of blood is found a substance which, from its tough fibrous nature, has received the name of fibrine. This is eliminated from fresh and warm blood by beating it with a bundle made of thin willow or birch twigs. The fibrine adheres to the twigs, and blood so treated remains fluid, instead of, as is otherwise the case, coagulating. We think that at many of the larger slaughter-houses you can buy defibrinated blood.

Manufacture of Alum.—(Reply to "A.")—You would do well to consult Payen's "Chimie Industrielle," also Wagner's "Jahresberichte über die Fortschritte der Technologie," and Elsner's "Chemisch-Technischen Mittheilungen," all of which you may inspect at the Library of the Commissioners of Patents, where you will also find several other periodicals and books, published recently in various countries, treating on technology and chemistry applied to manufacturing industry.

TO CORRESPONDENTS.

*** The Students' Number of the Chemical News will be published on Friday, September 8th. Gentlemen holding official positions in the Universities, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the Education, who have not yet forwarded the necessary information to our Office for publication in that number, will confer a favour by sending it with the least possible delay.

Chemicus.—The subject is treated very fully in an English edition of Wagner's "Chemical Technology." The work is now in the press and will be published by Messrs. J. and A. Churchill.

G. J. Warner.—The volume containing index to Gmelin's "Handbook" has not yet been published.

A. Keiffinheim and Co.—One of the best works on the subject is "Traité des Arts Céramiques," par A. Brongniart; Paris: Bèchet. Mr. Murray has published a work by J. Marryat on "A History of Pottery and Porcelain, Mediæval and Modern."

T. Limmers, jun.—(1). You may be able to obtain the journal containing the paper through Nutt and Co., Foreign Booksellers, Strand. (2). Consult article on the subject in Ure's "Dictionary of Arts and Sciences.

W. Foster.—Received with thanks.

A. Glendinning.—Thanks for the communication: it shall receive attention.

C. J. S.—See reply to E. J. L. in our "Notes and Queries" column.

NOTICE TO AMERICAN SUBSCRIBERS.

In answer to numerous inquiries, the Publisher begs to state that Subscribers in the United States can be supplied with the CHEMICAL NEWS from this Office, post free, for the sum of £1 2s. 4d. per annum payable in advance.

THE CHEMICAL NEWS.

VOL. XXIV. No. 615.

(STUDENTS' NUMBER.)

SCHOOLS OF CHEMISTRY.

EXAMINING BOARDS.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this Examination is £2.

The Examination will be held on Monday, January 8th, 1872, and includes the following subjects:—

NATURAL PHILOSOPHY.*

Mechanics—

Composition and Resolution of Statical Forces.

Simple Machines (*Mechanical Powers*):—Ratio of the Power to the weight in each.

Centre of Gravity.

General Laws of Motion, with the chief Experiments by which they may be illustrated.

Law of the Motion of Falling Bodies.

Hydrostatics, Hydraulics, and Pneumatics—

Pressure of Liquids and Gases, its equal diffusion, and variation with the depth.

Specific Gravity, and modes of determining it.

The Barometer, the Syphon, the Common Pump and Forcing-Pump, and the Air-Pump.

Acoustics—

Nature of Sound.

Mode and Rate of Propagation of Sound.

Musical Tones.

Optics—

Laws of Reflection and Refraction.

Formation of Images by Simple Lenses.

CHEMISTRY.

Heat—its sources. Expansion. Thermometers—relations between different Scales in common use. Difference between Temperature and Quantity of Heat. Specific and Latent Heat. Calorimeters. Liquefaction. Ebullition. Evaporation. Conduction. Convection. Radiation.

Chemistry of the Non-Metallic Elements; including their compounds as enumerated below—their chief physical and chemical characters—their preparation—and their characteristic tests.

Oxygen, Hydrogen, Carbon, Nitrogen. Chlorine, Bromine, Iodine, Fluorine. Sulphur, Phosphorus, Silicon.

Combining Proportions by weight and by volume. General Nature of Acids, Bases, and Salts. Symbols and Nomenclature.

The Atmosphere—its constitution; effects of Animal and Vegetable Life upon its composition.

Combustion. Structure and Properties of Flame, Nature and Composition of ordinary Fuel.

Water. Chemical peculiarities of Natural Waters, such as rain-water, river-water, spring-water, sea-water.

Carbonic Acid. Carbonic Oxide. Oxides and Acids of Nitrogen. Ammonia. Olefiant Gas, Marsh Gas, Sulphurous and Sulphuric Acids, Sulphuretted Hydrogen. Hydrochloric Acid. Phosphoric Acid and Phosphoretted Hydrogen. Silica.

* The Questions in Natural Philosophy will be of a strictly elementary character.

BACHELOR OF SCIENCE (B.Sc.)

This degree is conferred on candidates who pass a satisfactory examination in Mathematics, Mechanical and Natural Philosophy, Botany, and Vegetable Physiology, Zoology, and Chemistry.

FIRST B.SC. EXAMINATION.

No candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The examination will commence on Monday, July 17th, 1872. It is conducted by means of printed papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

The First Examination includes the following subjects:—

NATURAL PHILOSOPHY.

Heat—

Sources of Heat; conduction—convection.

Effects of Heat; expansion generally—of water—of gases and vapours; liquefaction; vaporisation; latent heat; expansive form of steam; dew-point; gases and vapours compared.

Specific Heat.

Thermometers; Pyrometers.

Heat in the Radiant state.

Electricity—

Sources of Electricity.

Static Electricity; dual character—insulation—induction—specific inductive capacity—equivalent antithetic states—disruptive discharge — convection; Electroscopes—Leyden Jar, &c.

Dynamic Electricity; Conduction—the electric current—derived currents—induction of currents; Voltaic Pile and other voltaic arrangements.

Thermo-Electricity; Electro-Thermometer.

Magnetism—

Magnets, the Earth, &c.; Induction—communication—retention—Magnetic relations of iron, steel, &c.

Electro-Magnetism—as in the spark—in conducting media—in soft iron; Magneto-Electricity; principle of Electro-magnetic and Magneto-Electric machines.

Terrestrial Magnetism.

INORGANIC CHEMISTRY.

Matter; simple and compound.

Elementary bodies classed. Metallic and Non-Metallic bodies.

Chemical Combination and Mechanical Mixture. Solution.

Outlines of Crystallography. Isomorphism. Dimorphism. Allotropic conditions of matter. Chemical Affinity, Laws of Combination by weight and by volume, as deduced from the history of the individual elements. Equivalent Numbers. Equivalent Volumes. Symbolical Notation, including questions on the Unitary System. Formulæ. Nomenclature.

Chemical actions produced under the influence of Heat. Nature of Combustion. Structure and Properties of Flame. Principles of Illumination. Chemical action of Light. Photography.

Oxygen. Ozone.

Hydrogen. Water.

Nitrogen. Chemical constitution of the Atmosphere. Diffusion of Gases. The Oxides of Nitrogen; Nitric Acid. Ammonia.

Chlorine, Bromine, and Iodine. Their compounds with Oxygen and Hydrogen. Theory of Bleaching.

Fluorine and Hydrofluoric Acid.

Sulphur. Sulphurous Acid. Manufacture and Chemical applications of Sulphuric Acid. Other Oxygen compounds of Sulphur. Sulphuretted Hydrogen.

Phosphorus. Oxygen and Hydrogen compounds of Phosphorus. Theory of Acids. Monobasic, Dibasic, and Tribasic Acids.

Carbon. Carbonic Oxide and Carbonic Acid. The principal Hydrogen compounds of Carbon. Manufacture of Coal Gas.

Silicon and Boron. Their compounds with the elements previously enumerated.

Metals. Characters of Metals as a class. Metallurgical Processes. Alloys. Classification of the Metals.

Potassium. Nitre. Gunpowder. Theory of the action of Gunpowder.

Sodium. Manufacture of Carbonate of Soda.

Barium. Strontium. Calcium. Mortars. Cements.

Magnesium. Aluminum. Glass. Porcelain.

Manganese. Iron. Composition and properties of Cast-Iron, Wrought-Iron, and Steel. Chromium.

Cobalt. Nickel. Zinc. Cadmium.

Lead. Manufacture of White-Lead.

Copper. Mercury. Bismuth. Tin. Arsenic. Antimony.

Silver. Gold. Platinum.

Principal compounds of the Metals with the Non-Metallic Elements. Theory of Salts.

Principles of Mineral Analysis.

Principles of Electro-Chemistry.

For the First Examination, a knowledge of Inorganic Chemistry only is necessary.

Examination for Honours.

Candidates for Honours in Chemistry are examined in any of the following subjects, at the option of the Examiners:—

Elementary Substances and their combinations.

Electro-Chemistry.

Radiant Chemical Action.

In the Examination for Honours, the Candidate, being not more than twenty-two years of age, who most distinguishes himself in Chemistry and Natural Philosophy, will receive an Exhibition of Forty pounds per annum for the next two years.

Second B.Sc. Examination.

This Examination commences on Monday, October 23rd, Candidates for this Examination who have not previously taken the degree of B.A. are required either to have passed the First B.Sc. Examination at least one Academical year previously, or to have passed the First M.B. Examination, in this University.

The Fee for this Examination is £5.

This Examination embraces Organic Chemistry, including the following subjects:—

Ultimate analysis of Organic bodies. Calculation of Empirical Formulæ. Methods of controlling Empirical Formulæ. Determination of the Equivalents of organic acids and bases; examination of products of Decomposition: determination of the Vapour-density of volatile bodies.

Law of Substitution. Compound Radicals. Homologous Series.

The Chemical History of the Cyanogen group. Cyanogen. Hydrocyanic Acid. Cyanic Acid and Urea. Fulminates. Cyanuric Acid. Sulphocyanic Acid. Chlorides of Cyanogen. Uric Acid.

Amylaceous and Saccharine substances. Fermentation. Alcohol, Wine, Beer, Bread, &c.

Homologues of Alcohol. Ethers, simple and mixed. Oxidation of Alcohol. Aldehyde and Acetic Acid, and their homologues. Anhydrides, simple and mixed. Compound Ethers.

Diatomic Alcohols and their Acids. Glycol and Oxalic Acid and their homologues.

Triatomic Alcohols. Glycerine. Fatty and Oily bodies. Saponification.

Vegetable Acids;—the principal.

Ammonia and its Derivatives. Ammonium and Ammoniacal Salts. Amides and Amines; their Classification. The chief Natural Organic Bases.

Colouring Matters. Indigo and its derivatives. Principles of Dyeing.

The chief constituents of the Vegetable organism. Cellulose, Vegetable Fibrin. Albumen, Casein, Glutin, &c.

The chief constituents of the Animal organism. Animal Fibrin, Albumen, Casein, Gelatin. Blood, Milk, Bile, Urine, &c.

Decay, Putrefaction. Destructive Distillation.

The Chemical Principles of the process of Nutrition and of Respiration in Plants and Animals.

Examination for Honours.

The Candidate, not more than twenty-three years of age, who, in the Examination for Honours, most distinguishes himself in Chemistry, will receive Fifty pounds per annum for the next two years, with the title of University Scholar.

Doctor of Science (D.Sc.).

This Examination is held within the first twenty-one days of June, and occupies four days.

No Candidate is admitted to the Examination for the Degree of D.Sc. until after the expiration of two Academical years from the time of his obtaining the Degree of B.Sc. in this University.

Candidates for the Degree of D.Sc. in any year, must give notice of their intention to the Registrar, and pay to him a Fee of Ten pounds, on or before the 1st of April.

Chemical Candidates can be examined either in Inorganic or Organic Chemistry; but no Candidate will be approved by the Examiners unless he has shown a thorough practical knowledge* of the *Principal Subject*, and a general acquaintance with the *Subsidiary Subject*, or *Subjects*, specified as belonging to the Branch so selected.

Inorganic Chemistry.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or, Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

Organic Chemistry.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or, Chemical Technology, in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

EXAMINATIONS IN CONNECTION WITH THE DEPARTMENT OF SCIENCE AND ART, SOUTH KENSINGTON.

A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

This sum is administered by the Science and Art Department.

The object of the grant is to promote instruction in Science, especially among the industrial classes, by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.

The following are among the Sciences towards instruction in which aid is given:—Acoustics, Light, Heat, Magnetism, and Electricity, Inorganic Chemistry, Organic Chemistry, Geology, Mineralogy, Mining, Metallurgy.

The assistance granted by the Science and Art Department is in the form of—1. Public Examinations, in which Queen's Medals and Queen's Prizes are awarded, held at all places complying with certain conditions. 2. Payments on results to teachers. 3. Scholarships and Exhibitions. 4. Building Grants. 5. Grants towards the purchase of apparatus, &c.

* It must be understood that the candidate for the Degree of D.Sc. is expected to be so fully conversant with the principal subject he may select, as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied.

CHEMICAL LECTURES AND LABORATORY INSTRUCTION.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Dean.—Professor A. W. Williamson, Ph.D., F.R.S.

Vice-Dean.—Professor G. Fuller, C.E.

The Session begins on Tuesday, the 3rd of October, and ends on Friday, the 21st of June.

It is divided into three terms, as follows: Michaelmas term, from October 3rd until December 20th; Lent term, from January 4th, 1872, till March 16th; Summer term, for Lectures, from March 18th till June 6th, all inclusive.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

A. General Course.

Lectures daily, except Saturday, from 11 to 12 a.m.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m.

Fee for the Whole Course of Lectures, £6 6s.; for a Half Course, £3 3s; Perpetual, £9 9s.; for the Organic Course alone, £2 2s.

Fee for the Exercise-Class—For the Course, £2 2s.; for the Half Course, £1 1s.

The Instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by Tutors, under the direction of the Professor.

The First Half of the Course to Christmas includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Second Half of the Course, extending from January to March, includes the following subjects:—

I. Preparation and properties of the chief metals, including their characteristic reactions and most important salts. Detection of Metallic Poisons. Quantitative Estimation of Metals. Principles of Classification. Monatomic Diatomic Metals, &c.

A weekly *viva voce* examination is held during the First Half Course and the commencement of the Second Half Course.

II. *Organic Chemistry.*

This commences in the second week in February, and occupies Five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

The first year is occupied with attendance on the Courses of Chemistry and of Analytical Chemistry. In the second year the Student again attends the Course of Chemistry, and is entrusted with teaching work in conjunction with the Tutors of the Class. At the same time time he continues to work in the Laboratory at analysis and original research.

In order to qualify themselves for rising to the higher ranks of the Profession, gentlemen remain for a further period, in which case they may obtain remunerative work in teaching through the recommendation of the Professor.

B. Analytical and Practical Chemistry.

I. Birkbeck Laboratory.

The instruction in the Laboratory is intended for beginners as well as for more advanced students. It includes practice in the construction and use of apparatus for preparing the common gases, acids, bases, salts, &c., study of the qualitative methods of detecting and separating mineral or organic bodies from one another; also quantitative analyses in the wet way, organic analyses, vapour-densities, &c.; instruction in gas analysis.

More advanced students are instructed in the methods of original research, especially in organic chemistry.

When accompanied or preceded by attendance on the Lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemisrry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture &c. Instruction is given in the principles and processes of Gas Analysis.

The Laboratory and Offices are fitted up completely with the most improved apparatus and utensils for experimental research, both for beginners, and for advanced Students. They are open daily, from 9 a.m. to 4 p.m., from the 4th of October until the end of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials. A deduction of about 40 per cent is made for Students who can attend only three fixed days per week.

A Gold Medal and Certificates of Honour are competed for by students entered for the Session.

II. Summer Courses.

I. *Elementary Course.*

About Forty Lessons, of one hour each, on Tuesday, Wednesday, Thursday, and Friday, from 11 to 12, commencing in the first week of May. Students are taught the construction and use of apparatus for the preparation of the most important gases, acids, &c. The characteristic tests for the presence of the common acids and bases, including the chief metallic and other poisons. Also the processes for separating these bodies from one another.

Solutions are frequently given in the class for investigation.

The first six weeks of the Course are occupied by the study of the chief non-metallic elements, and their simple compounds. Metallic salts, &c., are subsequently studied.

Fee, including cost of materials and apparatus, for the Course, £4 4s.; perpetual, £7 7s.

II. *Senior Course.*

This Course consists of Twenty Lessons, of two hours each, on Mondays and Saturdays, from 10 to 12, commencing in the first week in May. The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerine, alkaloids, &c.

The second half of the Course includes tests for mineral poison in organic mixtures; also tests for organic bodies, such as uric acid, albumen, sugar, alkaloids, &c., when mixed with other organic compounds, as in urine, blood, &c., or in food.

Volumetric methods of the quantitative analysis of sugar and urea are practised.

Fee, including cost of materials and apparatus, for the Course, £4 4s.; perpetual, £7 7s.

C. Summer Matriculation Course.

Professor Williamson, F.R.S., assisted by Mr. F. S. Barff, M.A., F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of Oral Lessons. The Practical Lessons include the preparation of the common gases and acids, &c., and the study of their characteristic properties in relation to the elementary laws of combination.

The other lessons are chiefly devoted to those parts of the subject which require fuller oral explanation than is given in the practical lessons. They include numerous

exercises and questions, to which answers in writing are given by the Students. These Lessons will begin on Wednesday, April 5th, at 11 a.m.

The class will meet on Tuesdays, Wednesdays, Thursdays, and Fridays, from 11 to 12; and some other meetings will be announced when the Class has assembled.

Fee for the class, £4 4s., including cost of materials and apparatus.

EVENING CLASSES.

The Session is divided into three Terms, each of ten complete weeks, exclusive of vacations—

I. The Michaelmas Term, beginning on Monday, the 9th of October, and ending on Thursday, December 14th.

II. The Lent Term, beginning on Monday, the 8th of January, and ending on Thursday, March 14th.

III. The Summer Term, beginning on Monday, the 18th of March, and ending on Thursday, June 6th; the Easter Vacation extending from the 28th of March to the 8th of April, both days inclusive.

The object of these classes is to extend the benefits of the College Tuition especially to gentlemen engaged elsewhere during the day, and to provide Instruction in subjects not taught in the ordinary College Classes.

The Beadles have orders to admit gentlemen to any of the Classes, with the permission of the Professor or Teacher, as occasional visitors.

The Library is open for the convenience of the Students between 6.30 and 8.30 on the evenings when the Classes meet, except when it is wanted for other purposes.

Elementary Chemistry—Theoretical and Practical.

Professor Williamson, F.R.S., and Mr. Jones. Monday, from 6.30 to 8.30.

A Course of Twenty Lessons, of two hours each, in the Michaelmas and Lent Terms.

The elements of Chemistry are explained to the Class, and the experiments illustrating the subject are performed by the Students.

The subject will be the common Non-Metallic Elements and the common Metals, their compounds and chief Properties, and the best method of distinguishing and separating them.

All the experiments and analyses are repeated by each Student, or by not more than two Students jointly.

Fee, including the cost of materials, &c., £4 4s. for the whole course, or £2 2s. per Term.

ROYAL SCHOOL OF MINES AND COLLEGE OF CHEMISTRY.

Professor of Chemistry.—Dr. E. Frankland, F.R.S.

The instruction in Chemical Science embraces:—

1. A course of Lectures on Experimental Chemistry, with special reference to the applications of Chemistry in the Arts and Manufactures.

2. A systematic Laboratory Course for the Practice of Chemical Analysis.

Chemical Lectures.—The Course consists of Forty Lectures on Mineral Chemistry and Thirty Lectures on Organic Chemistry.

The Lectures are delivered at the Royal College of Chemistry, Oxford Street.

Chemical Laboratory.—The general Laboratory for instruction in chemical manipulation in qualitative and quantitative analysis, and in the method of performing chemical researches, is under the direction of Dr. Frankland, and will be opened on Monday, the 2nd of October, 1871. The Royal College of Chemistry being the property of the Government, its Laboratories are used for the instruction of the pupils of the Royal School of Mines.

There are three terms in the collegiate year, of three months each, commencing in the first week of October, January, and April respectively. The Laboratory hours are from 10 a.m. to 5 p.m., with the exception of Saturdays, when the Laboratory closes at 2 o'clock.

Each Laboratory Student works independently, there being no classes. All operations are superintended by the Professor and his assistants. A table with drawers, cupboards, and shelves, is appropriated to every pupil, The institution supplies gas, fuel, and reagents. The larger and more expensive instruments of the Laboratory, such as air-pumps, thermometers, barometers, condensers, &c., may be used by the students, who are held responsible for their safety. The students have to provide themselves only with the apparatus specified in the Laboratory regulations. More advanced students engaged in private researches have to supply themselves with such materials as are not included amongst the ordinary reagents of the Laboratory.

Professor of Metallurgy.—Dr. Percy, F.R.S.

The course of instruction in Metallurgy consists of Lectures and Laboratory Practice.

The object of the Lectures is the communication of such instruction as the student may be able to apply to the greatest practical advantage, when he may be subsequently engaged in conducting any metallurgical process.

Metallurgical Laboratory.—This Laboratory is conducted by Mr. R. Smith, under the direction of Dr. Percy, and is devoted to practical instruction in Metallurgy. It will be opened on the 2nd of October, 1871. The nature of this instruction will be adapted to the special requirements of the Students. It comprises:—Assaying in all its branches, especially of the more important metals, such as iron, copper, lead, tin, alloys of silver and gold, &c., and the examination of ores and metallurgical products.

The ability of the student to make trustworthy assays is in every case thoroughly tested; and no certificate of competency is given to a student who has not furnished satisfactory proof that he is able to obtain accurate results.

There are three terms in the collegiate year of three months each. The Laboratory hours are from 10 to 4 during November, December, January, and February; and from 10 to 5 during the other months, with the exception of Saturdays, when the Laboratory is closed.

The charge for instruction in the Metallurgical Laboratory is £15 for three months; £12 for two months; and £7 for one month.

Lectures to Working Men.—Short Courses of Lectures at suitable periods of the year are given in the evening to working men. These courses are systematic, and arranged so as to illustrate, within a period of two years, the principal subjects taught at the Institution. Those for the ensuing Session include Chemistry, Metallurgy, Physics, Applied Mechanics.

KING'S COLLEGE.

Professor of Chemistry and Practical Chemistry—C. L. Bloxam, F.C.S.

Demonstrator—W. N. Hartley.

Assistant do.—J. M. Thompson.

The session commences on the 2nd of October, 1871. Students of the first and second years are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a view of the forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic Elements and their principal compounds are described.

The metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts, and the processes of the different Manufactures of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *viva voce* and by written papers, are held at intervals during the course at the usual Lecture hour.

Third Year.—Students who have completed six Terms in this Department are admitted to a course of Practical Chemistry, consisting of Twelve Demonstrations in each term; and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this department may be admitted to this Class at any period of his study, on payment of an extra fee.

Analytical and Experimental Chemistry.—Besides the Course of Chemical Lectures and the Summer Class of Practical Chemistry, provision is made for those Students who wish to become more minutely acquainted with the practical details of the Science. By means of this Class each Student is enabled to familiarise himself with the methods of analysis and research. After passing through a preliminary course of analytical operations, each Student devotes himself to such portions of the science as are most interesting to himself, or most likely to be practically useful to him. The Daniel Scholarship of £20, tenable for two years, is given every alternate year for original research in the Laboratory.

The Fees for admission to the Laboratory Class, exclusive of materials, are, for one month, £4 4s.; for three months, £10 10s.; for six months, £18 18s., &c.

EVENING CLASSES.

Classes for Evening Instruction are held at King's College from October to March, and during April, May, and June.

The Classes include one for the Elements of Chemistry and one for Practical Chemistry.

The fee for the former is £1 11s. 6d.; for the latter, £2 2s. The classes meet twice a week.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.

17, BLOOMSBURY SQUARE, W.C.

School of Pharmacy. The Session (1871-72) will commence on Monday, October 2nd, and extended to the end of July.

LECTURES ON CHEMISTRY AND PHARMACY, BY DR. REDWOOD.

These Lectures will be delivered on Monday, Tuesday, and Wednesday mornings, at 9 o'clock.

Part 1.—Physics in relation to Chemistry and Pharmacy.
,, 2—Chemistry of Inorganic Bodies.
,, 3.—Chemistry of Organic Bodies.

Also Lectures on Botany and Materia Medica, by Professor Bentley. The first and second parts of this course, extending over the winter months, will be delivered at 17, Bloomsbury Square, on Friday and Saturday mornings, at 9 a.m. The third part of the course, on Systematic Botany, will be delivered at the Royal Botanic Gardens, Regent's Park, at 8 a.m.

Fees.—For registered apprentices and associates of the Society, for either of the above courses, £1 1s.; for either part separately, 10s. 6d. For those not connected with the Society, £2 2s. for either of the above courses; £1 1s. for either part separately. Students have free admission to the Library and Museum.

Laboratory.—The suite of Laboratories for Practical Instruction in General and Pharmaceutical Chemistry will be opened on Monday, the 2nd of October, under the direction of Professor Attfield, Ph.D. Fee for the entire session of ten months, Twenty-five Guineas. The Laboratories are open from 9.30 a.m. till 5 p.m. Students can enter at any period during the session.

Two Scholarships (the Jacob Bell Memorial Scholarship) of Thirty Pounds a year each, are open to competition annually in July.

The Board of Examiners meet monthly, and are required by the Pharmacy Act to examine "all candidates who may present themselves for examination in their knowledge of the Latin Language, in Botany, in Materia Medica, in Pharmaceutical and General Chemistry, and to grant Certificates of Competency."

CITY OF LONDON COLLEGE, LEADENHALL STREET, E.C.

The Annual Courses consist of three terms, each averaging ten experimental lectures: fee, 5s. per term. Subjects:—Junior Class, Chemistry—first year, Non-Metals; second year, Metals and (time permitting) Elements of Organic Chemistry. Senior class, 7 to 8 p.m., Practical Analysis.

BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION.

EVENING CLASSES.

Inorganic Chemistry—Mr. G. Chaloner. Tuesday, 8 to 9.
Practical Chemistry and Analysis—From 8 to 10, Saturday evenings.

ISLINGTON SCHOOL OF SCIENCE, WINDSOR STREET, ESSEX ROAD, N.

A Course of Thirty Lessons on Inorganic Chemistry, by Mr. J. Howard, on Fridays at 8.30. Fee, 5s.

Practical Chemistry and Qualitative Analysis.—Fridays, at 6.30.

Electricity and Magnetism.—Wednesdays, at 8.

NEW KENNINGTON INSTITUTE.

Lectures and Practical Classes in Chemistry, Pharmacy, Practical Chemistry, Botany, Materia Medica, Latin, Physics, and all subjects connected with the Pharmaceutical Examinations, under the direction of Dr. Muter. Popular Chemical Evening Classes for Commercial Analysis.

POLYTECHNIC INSTITUTION.

Course of Thirty Lessons in Inorganic Chemistry, under the superintendence of Professor Pepper. Tuesday, 8.30 to 10 p.m.

ROYAL VETERINARY COLLEGE, CAMDEN TOWN.

Chemical Professor.—Mr. R. V. Tuson.

LECTURES AT LONDON MEDICAL SCHOOLS.

ST. BARTHOLOMEW'S HOSPITAL & MEDICAL COLLEGE.

WINTER SESSION.

Lecturer.—Dr. W. J. Russell. Monday, Wednesday, and Friday, at 10 a.m. One course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—Dr. W. J. Russell. One course, £2 2s.

CHARING CROSS HOSPITAL AND COLLEGE

WINTER SESSION.

Lecturer.—Mr. C. W. Heaton, F.C.S. Monday, Thursday, and Friday, at 11. One session, £5 5s.
The Laboratory is open daily.

SUMMER SESSION.

Practical Chemistry.—Mr. Heaton, F.C.S. Monday and Friday. One session, £2 2s.

ST. GEORGE'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. H. M. Noad, F.R.S. Tuesday, Thursday, and Saturday, at 11.30. One course, £6 6s.

SUMMER SESSION.

Practical Chemistry.—Dr. Noad, F.R.S. Monday, Wednesday, Thursday, Friday, at 10. One course, including the use of apparatus and materials, £4 4s.

GUY'S HOSPITAL.

WINTER SESSION.

Lecturers.—Dr. Debus, F.R.S., and Dr. Stevenson. Tuesday, Thursday, and Saturday, at 11. One course, £4 4s.

SUMMER SESSION.

Practical Chemistry.—Dr. Debus, F.R.S. Monday, Wednesday, and Friday, from 10 to 1. One course, £4 4s.
Practical Instruction is also given in the laboratory by Drs. Debus and Stevenson during the Winter Session.

The Course of Lectures on Experimental Philosophy (Heat, Electricity, Magnetism, and Electro-Magnetism) is given on Wednesdays at 12 noon by Dr. Stevenson.

LONDON HOSPITAL.

Lecturers on Chemistry.—Henry Letheby, M.B., and C. Meymott Tidy, M.B. Monday, Wednesday, and Friday, at 10.30 a.m.

Practical Chemistry.—Dr. Letheby, M.B. Monday, Tuesday, and Saturday, at 9 a.m.

ST. MARY'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. C. R. A. Wright, F.C.S. Monday, Tuesday, Thursday, and Friday, at 10.15. £5 5s.

SUMMER SESSION.

Practical Chemistry.—Dr. C. R. A. Wright, F.C.S. Tuesday and Thursday, at 11.30 a.m.; and Saturday, at 9 a.m. One session, £3 3s.

MIDDLESEX HOSPITAL.

WINTER SESSION.

Lecturer.—Mr. Heisch. Monday, Wednesday, Friday, and Saturday, at 11. One session. £6 6s.

SUMMER SESSION.

Practical Chemistry.—Mr. Heisch. Monday, Wednesday, and Friday, at 11. One session, £3 3s.

ST. THOMAS'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. A. J. Bernays. Wednesday, Thursday, and Friday, at 9. One course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—Dr. A. J. Bernays. Tuesday and Thursday, 10 to 12; Friday, 11; Saturday, 10 to 1. One course, £3 3s.

WESTMINSTER HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. A. Dupré, F.C.S. Tuesday and Thursday, at 3 p.m.; Friday, at 3.30 p.m. One course, £5.

SUMMER SESSION.

Practical Chemistry.—Dr. A. Dupré, F.C.S. Tuesday and Thursday, at 10 a.m. One course, £2.

PRIVATE TEACHERS OF CHEMISTRY IN LONDON.

Mr. J. C. Braithwaite, 54, Kentish Town Road, N.W.—Chemistry and Toxicology, Monday and Thursday; Latin, Tuesday and Friday; Botany and Materia Medica, Wednesday and Saturday. All the classes commence at 8 p.m. Laboratory and Botanic Garden open daily, except Saturdays.

Mr. Henry Matthews, F.C.S.—Laboratory, 60, Gower Street, Bedford Square. Instruction in all branches of Practical Chemistry, particularly in its application to Medicine, Agriculture, and Commerce. Laboratory open daily, except Saturday, from 10 to 5; on Saturday, from 10 to 1.

Dr. John Muter, M.A.—Laboratory, 289, Kennington Road. Prepares for examinations of Pharmaceutical Society.

Mr. John Newlands, F.C.S.—Laboratory, 13, Knowle Road. Brixton, S.W. Gives practical instruction in Analysis, and prepares gentlemen for various public examinations.

Mr. A. Vacher, 20, Great Marlborough Street, Regent Street.

UNIVERSITY OF OXFORD.

Professor of Chemistry.—Sir B. C. Brodie, Bart., M.A., F.R.S.

Demonstrator.—E. Madan, M.A.

A commodious Laboratory is attached to the New Museum.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other Colleges, by competitive examination in Natural Science.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A.

MICHAELMAS TERM.

Practical Chemistry, by the Professor, on Mondays, Wednesdays, and Fridays, at 1 p.m.

LENT TERM.

Chemistry, by the Professor, on Mondays, Wednesdays, and Fridays, at 12.

Practical Chemistry, on the same days, at 1 p.m.

EASTER TERM.

Chemistry, by the Professor, on Mondays, Wednesdays, and Fridays, at 12.

Practical Chemistry, on the same days, at 1 p.m.

The Chemical Laboratory of the University is open daily, from 10 a.m. till 6 p.m; so that students can work there at such times as may be convenient to them: and the Professor will attend to give instruction at the times above specified.

PROVINCIAL SCHOOLS.

BIRMINGHAM.—MIDLAND INSTITUTE.

Lecturer on Chemistry.—Mr. C. J. Woodward, B.Sc. Tuesday and Thursday, at 8 p.m.

Practical Chemistry.—Mr. C. J. Woodward, B.Sc. Saturday, 3 to 6, and 6.30 to 9.30 p.m.

BIRMINGHAM.—QUEEN'S COLLEGE.

WINTER SESSION.

Professor of Chemistry.—Alfred Hill, M.D., Borough Analyst. Tuesday, Thursday, and Friday, at 12.

SUMMER SESSION.

Practical Chemistry.—Professor A. Anderson. Thursday and Friday, at 2 p.m.

BRISTOL.—BRISTOL MEDICAL SCHOOL.

WINTER SESSION.

Lecturer.—Mr. Thomas Coomber, F.C.S. Monday, Tuesday, Wednesday, and Thursday, at 8.15. One Course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—M. T. Coomber, F.C.S. Daily except Saturday, at 8 a.m. One course, £3 3s.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—A. H. Church, M.A. Oxon.

Assistant.—E. Kinch.

The Autumn Session commenced on the 15th of August: it divides on the 6th of October, and terminates about the 21st of December.

The chemical instruction comprises Three Courses of Lectures and Laboratory Practice:—

(1). 32 Lectures on Inorganic Chemistry.
(2). 32 Lectures on Organic Chemistry.
(3). 24 Lectures on Agricultural Chemistry.
(4). 32 Lessons on Chemical Manipulation.
(5). 32 Lessons on Qualitative Analysis.
(6). 32 (or more) Lessons on Quantitative Analysis.

Catechetical Lectures are also given, while analyses of manures, oil-cakes, minerals, soils, waters, &c., are daily performed in the College Laboratories, and Chemico-Agricultural researches undertaken by the more advanced

Students, under the immediate direction of Professor Church.

The text-books used are Church's "Laboratory Guide," Roscoe's "Chemistry," and Church and Dyer's edition of "How Crops Grow."

LIVERPOOL ROYAL INFIRMARY SCHOOL OF MEDICINE.

Lecturer on Chemistry and Toxicology.—Dr. J. Campbell Brown.

1. Course of 100 Lectures. Monday, Tuesday, Thursday, and Friday, at 10.15. £5 5s.
2. Practical Organic Chemistry for Senior Students. £3 3s.
3. Practical Chemistry. Summer Class; Fifty Lessons. £3 3s.
4. Toxicology. Twelve Lectures.
5. Technical Students are admitted on five days of the week into the Private Laboratory, which is open from 10 to 4.

ANALYTICAL LABORATORY AND SCHOOL OF TECHNICAL CHEMISTRY.

7 AND 9, HACKIN'S HEY, LIVERPOOL.

Conducted by Mr. A. Norman Tate.

Pupils may attend at any time between the hours of 9.30 a.m., and 5 p.m. (Saturdays, 9.30 a.m. and 1 p.m.). and may work every day, or any numbers of days, or portion of a day in the week, and for any period most convenient to themselves.

The Laboratory is also open two evenings per week for practical work.

Lectures one evening each week.

A separate working bench is provided for each Student, and he is also supplied with all ordinary chemicals, gas, fuel, and the more substantial portions of Laboratory apparatus, but must provide himself with test-tubes, beakers, and other apparatus of a fragile nature.

In addition to the ordinary chemical studies, the course of instruction will, as far as possible, comprise all such studies as may be required for the successful prosecution of the particular branch or branches of Applied Chemistry in which the pupil is to engage; as, for example, in the case of one intended for manufacturing pursuits, he would study architectural and mechanical drawing, so far as is required for the preparation of plans, &c., of chemical apparatus and manufactories, the nature and use of building materials, and the scientific principles and practical rules involved in building and constructive operations, and other scientific and practical information required in the arrangement, construction, and management of chemical manufactories, and the application of Chemistry to industrial pursuits.

COLLEGE OF CHEMISTRY, LIVERPOOL.

Founder.—Dr. Muspratt, M.D., &c.

Principal.—Mr. Martin Murphy, F.C.S., Professor of Chemistry.

The Course of Instruction given in the College of Chemistry comprises the teaching of Chemistry as a science, and the general application of chemical knowledge; also the teaching of the principles of those branches of physics which are allied with chemistry, such as light, heat, electricity, &c.

Particular attention is devoted to instruction in the practice of systematic analytical operations, whereby students will be enabled to determine accurately the general and proximate constituents of substances, and so arrive at a knowledge of their nature and properties.

Instruction in the application of chemical data to medicine and agriculture, and to the chemical and metallurgical operations, comprising Technology, will be given, to qualify students for these avocations.

The students will invariably be controlled and directed in their study and work by the Principal and competent assistants. Ample laboratory accommodation is provided for students, and such general appliances as will facilitate their progress in acquiring a knowledge of the specialities taught in the college.

The student's laboratories are open throughout the year. Hours of attendance—From 10 a.m. to 5 p.m. daily.

Fees—10 guineas per quarter of 3 months, or 35 guineas per annum, payable in advance. Students provide all their own apparatus and books.

Medical and Pharmaceutical students are admitted for 1 hour per day. Fee for 3 months, £2 2s.

A Course of Lectures will be delivered to the students during the winter months. Evening Classes.

Certificates of attendance recognised by the University and Apothecaries' Hall of London, and Apothecaries' Hall of Ireland.

LEEDS SCHOOL OF MEDICINE.

WINTER SESSION.

Lecturer.—Mr. J. Chapman Wilson, F.C.S.

Daily, except Saturday, at 11 a.m. One course, £4 4s.

SUMMER SESSION.

Practical Chemistry.—Mr. Wilson, F.C.S.

Tuesdays and Thursdays, 11 to 12.30. One course, £2 2s.

LEEDS MECHANICS' INSTITUTION AND LITERARY SOCIETY'S LABORATORY.

SESSION 1871—72.

Chemical Classes for Instruction in Elementary, Practical, and Analytical Chemistry.

Teacher.—Mr. George Ward, F.C.S.

HIGH HARROGATE COLLEGE, YORKSHIRE.

Professor of Chemistry.—Mr. W. G. Mason, F.C.S., Certificated Science Teacher.

MANCHESTER GRAMMAR SCHOOL.

CHEMICAL DEPARTMENT.

Professor.—W. Marshall Watts, D.Sc. Lond.

Instruction is given in Inorganic Chemistry, Organic Chemistry, Metallurgy, and Analytical Chemistry. A lecture-room and second laboratory, affording accommodation for seventy-two students, have just been completed.

Michaelmas Term commences on Tuesday, September 19th.

MANCHESTER ROYAL SCHOOL OF MEDICINE.

Lecturer on Chemistry.—Mr. Daniel Stone.

The usual course for the Medical Boards.

A Laboratory is connected with the school.

OWEN'S COLLEGE, MANCHESTER.

(IN CONNECTION WITH THE UNIVERSITY OF LONDON).

Chemistry.—Professor H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Junior Class.—Wednesday and Saturday, from 9.15 to 10.15 a.m.

Subject: Inorganic Chemistry, comprising the laws of chemical combination, and a description of the properties and mode of preparation of the non-metallic elementary bodies and their most important compounds.

Senior Class.—Tuesday and Thursday, from 9.15 to 10.15 a.m.

Subjects: Inorganic and Organic Chemistry, including the properties of the metals and their compounds, and the composition and relations of the best defined groups of organic bodies, and the laws regulating their formation.

Students are expected to answer the written exercises and attend the *viva voce* examinations given in these classes.

Fee—For each class, £3 3s. For both classes, £5 5s.

A Recapitulatory Lecture, without additional Fee, will be given on Friday at 9.15 a.m., which members of both classes will be required to attend.

Extra Class.—Wednesday, from 4 to 5 p.m.

Subject: Technological Chemistry.

The Chemical Principles involved in the most important Chemical Manufactures will be chiefly considered in this course.

Students attending this class must be acquainted with the principles of Chemical Science. Fee, £2 2s.

Analytical and Practical Chemistry.

LABORATORY COURSE.

Professor.—Henry E. Roscoe, B.A., Ph.D., F.R.S.

Senior Assistant.—Mr. C. Schorlemmer, F.R.S.

The aim of this course is to make the student practically acquainted with Chemical Science, to enable him to conduct analysis and original research, and to fit him for applying the science to the higher branches of Art, Manufactures, and Agriculture. To accomplish this, an attendance of not less than four days per week during three whole sessions is as a rule necessary. It is very advisable that each Laboratory Student should attend or should have attended the course of Lectures on Theoretical Chemistry.

The College Laboratory will be open for students daily from 10.30 a.m. until 5 p.m., except Saturdays, when it will be closed at 1.30. The Laboratory is closed from 1.15 until 2, for dinner.

The Laboratory is fitted with every convenience for the prosecution of practical chemistry, all branches of qualitative and quantitative analysis, and original research.

Each student is provided with a separate working table, set of tests, fuel, water, and gas, free of expense; but he is required to find his own apparatus, a few of the more expensive reagents, and the chemicals required for his experiments. Other apparatus or instruments of a more expensive description may be obtained on loan from the Laboratory Steward, subject to regulations to be prescribed by the Professor.

Fees for the Session.—Students working six days per week, £21; ditto, four days, £17 17s.; ditto, three days, £13 13s.; ditto, two days, £9 9s.; ditto, one day, £5 5s.; Students entering the Laboratory Class at or after Christmas, for not less than two days per week, will be charged two-thirds of the fees for the whole session.

Special Fees for Shorter Periods.—For six months, six days per week, £17 17s.; five months, ditto, £15 15s.; four months, ditto, £13 13s.; three months, ditto, £10 10s.; two months, ditto, £7 7s.; one month, ditto, £4 4s.

Lectures on the methods of Qualitative and Quantitative Analysis, intended to supplement the instruction in Practical Chemistry, will be given by Mr. Schorlemmer, on Mondays, from 4 to 5 p.m.

First year's Laboratory Students are recommended to attend and answer the written exercises and the *viva voce* questions given in this class. Fee, £1 11s. 6d.

Chemical Calculations.—In this class, instruction and special practice is given, by Mr. Schorlemmer, on Wednesday, from 4 to 5 p.m., in the methods of Chemical Calculations, serving as supplementary to the Lecture and Laboratory Courses. Fee, £1 1s.

The Lectures on Chemistry in Owen's College are recognised by the University of London for its Medical Degrees, by the Royal College of Surgeons, and by the Apothecaries' Hall.

EVENING CLASSES.

Chemistry.

Professor H. E. Roscoe, B.A., Ph.D., F.R.S.

Lecture Class.—(First Course—The Non-Metallic Elements).—Monday, from 8.35 to 9.35 p.m.

Lecture Class.—(Second Course—The Metals). Friday, from 8.35 to 9.35 p.m.

Lecture Class.—(Third Course—Organic Chemistry).—Mr. C. Schorlemmer, F.R.S. Thursday from 8.35 to 9.35 p.m.

Laboratory Courses of Practical Chemistry.

Professor Roscoe, F.R.S., and Mr. Schorlemmer, F.R.S.

Junior and Senior Divisions.—Monday, From 6 to 8.30 p.m.

Pharmaceutical Course.—Monday and Wednesday.

COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

(IN CONNECTION WITH THE UNIVERSITY OF DURHAM).

Professor of Chemistry.—A. Freire-Marreco, M.A.

First Course.—Michaelmas Term: General Principles of Chemistry; History of the Non-metallic Elements.

Second Course.—Epiphany Term: History of the Metals and their more important compounds; Principles of Qualitative Analysis, Monday, Tuesday, Wednesday, and Thursday, at 9 a.m.; Examinations, Friday at 9 a.m.

Third Course.—Easter Term: Elements of Organic Chemistry, Monday and Wednesday, at 9 a.m.; Examinations, Friday at 9 a.m.

Mineralogical Chemistry, Tuesday and Thursday, at 9 a.m.; Examinations, Saturday at 9 a.m. Fee, five guineas; single Courses, two guineas each.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m.

Laboratory Fees.—Students working six days per week, five guineas per term. Students working alternate days, three guineas per term. Students working one day per week, one guinea per term.

SHEFFIELD.

SCHOOL OF CHEMISTRY,

1, SURREY STREET, SHEFFIELD.

Mr. A. H. Allen, F.C.S., delivers a Course of Twenty-four Lectures on Applied Chemistry, in connection with the Science and Art Department.

Day and Evening Classes for Analytical Chemistry.

SHEFFIELD SCHOOL OF MEDICINE.

During the Winter Session, Mr. A. H. Allen, F.C.S. will deliver a Course of Forty-five Lectures on Chemistry.

The Practical Chemistry Class, will meet three times a week during the Summer Session.

Mr. W. Baker, F.C.S., lectures on Chemistry at the Sheffield Collegiate School. Laboratory for Instruction in Theoretical and Practical Chemistry, 46, High Street, Sheffield.

SCOTLAND.

UNIVERSITY OF EDINBURGH.

Professor of Chemistry.—Dr. A. Crum Brown, F.R.S.

ROYAL COLLEGE OF PHYSICIANS AND SURGEONS, EDINBURGH.

Lecturer on Chemistry.—Dr. Stevenson Macadam. F.R.S.E.

The Courses of Instruction in Chemistry include its applications to Medicine, Agriculture, and the Industrial Arts; and they qualify for the University of Edinburgh and other Universities, the Royal Colleges of Physicians and Surgeons, the Navy, Army, and Indian Medical Service, and the other Medical and Public Boards.

The Lectures on Chemistry are delivered daily during the five months of the Winter Session. The Lectures form a complete Course; the New Nomenclature and Notation are employed throughout, and special Lectures in Technological Chemistry are given. Tutorial Class Examinations are held during the Session, and Excursions are arranged for visiting the principal Chemical Manufactories.

The Instructions in Analytical Chemistry are conducted in the Laboratories at Surgeons' Hall, which are now open daily, under the personal superintendence of Dr. Macadam, for the instruction of gentlemen in Chemical Analysis, and the prosecution of researches in Manipulative Chemistry.

The Prelections in Practical Chemistry are also conducted in the Laboratories at Surgeons' Hall. The subjects

selected for Examination are those with which Medical Students are specially called upon to exhibit a practical acquaintance.

Fees.—Lecture, £3 5s. (University Graduation, £4 4s.) Practical Chemistry (University, &c.), £3 3s.; Analytical Chemistry, £2 per month, £5 for three months, or £10 for six months.

UNIVERSITY OF GLASGOW.

Professor of Chemistry and Practical Chemistry.—Dr. Thomas Anderson, F.R.S.E.

ANDERSONIAN UNIVERSITY, GLASGOW.

Professor of Scientific Chemistry.—Dr. T. E. Thorpe.

GLASGOW MECHANICS' INSTITUTION.

Professor of Chemistry and Practical Chemistry.—Dr. R. Carter Moffat.

GLASGOW VETERINARY COLLEGE.

Professor of Chemistry.—Dr. R. Carter Moffat.

IRELAND.

DUBLIN.—TRINITY COLLEGE.

Professor of Chemistry.—Dr. Apjohn, F.C.S.

ROYAL COLLEGE OF SURGEONS, DUBLIN.

Professor of Chemistry.—Dr. Barker.

QUEEN'S COLLEGE, BELFAST.

Professor of Chemistry.—Dr. Andrews, F.R.S., &c.

QUEEN'S COLLEGE, CORK.

Professor of Chemistry.—Dr. Blyth.

QUEEN'S COLLEGE, GALWAY.

Professor of Chemistry.—Dr. T. H. Rowney.

A Laboratory for Practical Instruction is attached to all the Queens' Colleges. The usual Practical Course for the Medical Boards is given in the summer.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

This college supplies, as far as practicable, a complete course of Instruction in Science, applicable to the Industrial Arts. The subjects of Instruction are:—Pure and Applied Mathematics, Descriptive Geometry, and Mechanical Drawing, Mechanism, Theoretical and Applied Chemistry, Chemical Analysis, Physics, Botany, Zoology, Geology, and Palæontology, Mineralogy, Mining, Machinery, Surveying, and Agriculture.

Professor of Theoretical Chemistry.—W. K. Sullivan, Ph.D., V.P.R.I.

Professor of Analytical and Applied Chemistry.—R. Galloway, F.C.S.

Assistant Chemist.—W. Plunkett, F.C.S.

A course of Lectures on Inorganic and Organic Chemistry is delivered by Dr. Sullivan three times a week during the session. Fee for the entire course, £2.

A course of Lectures on Technological Chemistry is delivered by Mr. Galloway twice a week during the session. Fee for the course, £2.

The chemical and Metallurgical Laboratories, under the direction of Mr. Galloway, are open every week day during the session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical research. Each student is taught, not in class, but separately and independently; and he is supplied with a separate working table, with reagents, fuel, water, gas, and the larger and more expensive apparatus. Fee, for the session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships, of the value of £50 each, yearly, with free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with free Education, including Laboratory Instruction, tenable for three years; three become vacant each year. These are awarded at the annual May Examinations of the Science and Art Department.

A Diploma of Associate of the College is granted at the end of the three years' Course.

The Session commences on Monday, October 2nd.

NOTE ON REGIANIC ACID.*

By Dr. T. L. PHIPSON, F.C.S.

REGIANIC acid is one of several new substances which I have obtained during the last few years from the fruit of *Juglans regia*, and also from another species of walnut. To these substances allusion has already been made at a previous meeting of the British Association, and in the *Comptes Rendus* of the Paris Academy. The green husk of the walnut yields to benzol a yellowish substance crystallising in very elongated octahedra or feather-like groups of crystals. This substance, which I call *regianine*, is easily decomposed, and, when treated with alkalies or ammonia, gives a splendid purple-red solution, whence acids precipitate a brown flocconnous substance. The latter, re-dissolved in a weak solution of soda, re-precipitated with hydrochloric acid, after the addition of which the solution is boiled and washed with boiling water, gives a jet black amorphous substance, which is pure *regianic acid*, yielding to analysis the composition $C_6H_6O_7$, and forming a brown lead salt, $PbO,C_6H_6O_7$, also a jet black silver salt, very similar in appearance to the acid itself, and a lime salt of a beautiful pink colour, the precipitation of which is hastened by boiling with a little ammonia. Regianic acid is insoluble in water, but dissolves in alkaline solutions with a fine red-purple tint. These coloured solutions have no peculiar action upon the spectrum. It appears to be derived from regianine by oxidation, for when the latter is introduced with a little soda into a given volume of air, the whole of the oxygen is absorbed. Regianine is soluble in water, alcohol, and benzol; but its solution in benzol is the only one that can be kept for any length of time. The alcoholic solution is rapidly decomposed by exposure to the air and regianic acid, more or less pure, deposited.

LABORATORY NOTES.

ON THE DISTINCTION BETWEEN A PHOSPHATE AND AN ARSENIATE.

IT is well known that the difference in colour between silver phosphate and silver arseniate furnishes the most simple means of distinguishing between the two classes of salts. Presence of free nitric acid or ammonia interfering with the reaction, it is necessary to apply the test to a neutral solution, in which case many other salt radicals may be precipitated. If the phosphate or arseniate be first separated as the ammonia magnesium salt, it is usual to dissolve this precipitate in nitric or acetic acid before adding silver nitrate. This is quite unnecessary, the characteristic yellow phosphate or brown arseniate being immediately produced on addition of silver nitrate to the crystalline precipitate. This modification renders the test more delicate as the reaction takes place in a neutral liquid. A few streaks on a test-tube show the reaction very distinctly, hardly changing colour if due to

* Abstract of a Paper read before the British Association, Edinburgh Meeting, Section B.

phosphate, but turning quite brown if caused by arseniate, in each case becoming soluble in ammonia. On this account the ammonio-magnesium salt must be washed free from ammonia, which would either prevent the reaction or lead to confusion by precipitating brown silver oxide. Acetic acid dissolves both phosphate and arseniate of silver, the former far more readily than the latter. If, therefore, acetic acid be gradually added to a mixed precipitate of silver phosphate and arseniate, the phosphate dissolves first, and the brown colour of the arseniate becomes more apparent. If, after addition of a moderate quantity of acetic acid, the liquid be filtered, the dissolved phosphate may often be detected by cautious neutralisation with ammonia, when the yellow silver phosphate is thrown down, but this reaction is uncertain, as both phosphate and arseniate of silver are soluble in ammonium acetate, the phosphate more readily than the arseniate.

ALFRED H. ALLEN, F.C.S.

Sheffield, August 26, 1871.

MISCELLANEOUS.

New Appointment.—Mr. James Kilroe, ex-scholar of the Royal College of Science, Dublin, has been appointed Science Teacher in the Trade School at Saltaire, Leeds.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Moniteur Scientifique, Nos. 331 and 352 (double number), August 1 and 15, 1871.

This number contains the following original papers and memoirs bearing on chemistry and collateral sciences:—

Anthracen and its Derivatives.—Dr. E. Kopp.—We regret that it is impossible to quote here more than the headings of the various sections of this very complete and exhaustive monograph on this subject:—The anthracens of commerce—(*a*) crude anthracen of German origin, (*b*) crude anthracen of English, (*c*) of French manufacture; preparation of chemically pure anthracen; properties of semi-purified anthracen; properties of absolutely pure anthracen; formation and synthesis of anthracen—(1) by means of toluol or toluen, (2) by the action of heat alone upon toluol, (3) by the reaction of ethylen and styrolen upon benzine; hydrogenated derivatives from anthracen; action of chlorine upon anthracen. This essay is to be continued.

Best means of Artificial Illumination of Workshops and Factories.—A. Jouglet.—This essay, illustrated by a woodcut, treats at length on Rouille's autogen gas apparatus, already alluded to by us before (see CHEMICAL NEWS, vol. xxiv., p. 74).

Short Notes on the Maritime Exhibition held at Naples last year.—A. Jouglet.—This paper contains, among other interesting matter, some particulars on a new instrument invented by M. Esposito, and termed a *nausismographe*—viz., a contrivance which may be briefly described as an automatic log-book. This apparatus is highly eulogised by naval authorities of high standing—English, American, Russian, French, and others—and especially, also, by the eminent mathematician, the Rev. Father A. Secchi, S.J. Very properly the author of this paper here observes, "Parlez moi de sciences mathématiques pour produire l'accord entre des hommes venus de points opposés."

Bayerisches Industrie und Gewerbe Blatt, June, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Milk and Lactometers.—P. Neumann.—A lecture on this subject in its most exhaustive sense, treating, not simply on milk as usually understood, but on that fluid as secreted by mammalia in general, and also quoting a series of analyses of milk, the modes of testing milk, preserving it, and statistics relating to the number of cows found in various countries, per mille of the population thereof, and a detailed description of the various lactoscopes, lactometers, and other similar instruments.

Utility and Value of Carbonic and Lactic Acids in Beer.—A. Vogel.—The contents of this paper really bear upon the question, What effect have newly-built cellars upon Lager beer which is kept in casks? From a comparative experiment made by the author, it appears that, when fresh lime can absorb the carbonic acid contained in beer, the effect thereof is that the liquor becomes rapidly stale. As regards the lactic acid, a permanent constituent of good beer, it is due to the malt, and is of importance for keeping proteine compounds in solution in beer.

American Journal of Pharmacy, August, 1871.

In addition to several original papers and memoirs more particularly bearing upon pharmacy, this number contains the following original papers relating to chemistry;—

Bromide of Cerium.—C. Bullock.—The author prepares this salt (which, it appears, is used as medicine in the United States) by first taking oxalate of cerium, which, having been calcined in a porcelain capsule, the resulting sesquioxide was dissolved in hydrochloric acid (with copious evolution of chlorine). To the chloride of cerium thus obtained, carbonate of soda was added, yielding white carbonate of cerium insoluble in an excess of the alkaline carbonate. The carbonate of cerium was dissolved in hydrobromic acid, requiring nearly twice the weight of the sesquioxide in bromine as hydrobromic acid for saturation. The solution of bromide of cerium decomposes while evaporating, even at a low temperature, disengaging acid fumes. When evaporated to dryness, and pulverised, the salt has a light chocolate colour; the taste is somewhat sweet and very styptic. The salt is very deliquescent, and dissolves in alcohol of 95 per cent. The dry salt leaves an insoluble sediment in water, which sediment, of a light grey colour, was found to be protoxide of cerium.

Note on Chloral Hydrate.—Ch. A. Bœhme.—The author relates at length an occurence which appears to lead to the conclusion that chloral hydrate may be spontaneously decomposed when kept in sealed bottles, two of these, each containing 1 lb. of the substance alluded to, having been obtained from a leading drug-house at New York. One of the bottles was opened at once, and nothing special noted in its contents; the other bottle was placed in a store-room, and on being after some time opened, a dense cloud of fumes was observed to issue from its mouth. These fumes had the characteristic odour of chloral hydrate, but were more stifling, reddened blue litmus-paper, and, on further testing, were found to consist partly of hydrochloric acid. The lumps of the hydrate near the top of the bottle had crumbled to a crystalline powder freely soluble in water, somewhat in chloroform, but insoluble in sulphide of carbon and oil of turpentine. The author's opinion is that the sample alluded to might have been pure hydrate of chloral at first, and been decomposed by standing.

Action of Chlorides on Calomel.—J. Cummings.—According to Mialhe, calomel is in part converted into bichloride of mercury (corrosive sublimate) and metallic mercury, by chloride of ammonium and the chlorides of sodium and potassium. Dr. Gardner denies this statement. The author communicates a series of experiments made for the purpose of correctly ascertaining the real truth about these different assertions with the result that, in the case of the ammonium-chloride, there is some minute quantity of bichloride of mercury formed at 119° F., when the ammonium-chloride is, along with water, in contact with the calomel. With the chloride of sodium, the calomel is not so readily converted into bichloride, requiring thereto a higher temperature; but the addition of some drops of hydrochloric acid hastens the reaction. Calomel, digested alone with the acid just named for twelve hours at a temperature of 120° F., undergoes the same change, but is not affected at a lower temperature.

Analysis of a Silver Ore from Austin, Nevada.—J. L. Beeler.—In 100 parts, this ore was found to consist of—AgCl, 0·94; AgS_2 47·60; SbS_3, 11·31; PbS, 11·75; Cu_2S, 1·19; FeS_2, 3·23; SiO_3, 23·63 loss, 0·35—total, 100·0.

Shoe-Blacking without Acid.—Dr. Artus.—From 3 to 4 lbs. of lamp-black and ½ lb. of bone-black are well mixed with 5 lbs. of glycerine and treacle. Meanwhile, 2½ ozs. of gutta percha are cautiously fused in a copper or iron saucepan, and 10 ozs. of olive oil added, with continual stirring, and afterwards 1 oz. of stearine. The warm mass is added to the former mixture, and then a solution of 5 ozs. of gum senegal in 1½ lbs. of water, and 1 drachm each of oil of rosemary and lavender may be added. For use, the blacking is diluted with 3 to 4 parts of water. This blacking keeps the leather soft, and renders it more durable.

La Revue des Scientifique de la France et de l'Etranger, August 5, 1871.

This number does not contain any original papers relating to chemistry and thereto allied sciences, but we call attention to the lectures on the—

Influence of Heat Externally Applied to Animals.—Dr. C. Bernard.—Interesting in a physiological experimental view.

Climate of the Alsace.—Ch. Grad.—A valuable contribution to physical geography and meteorology.

August 12, 1871.

Contains no original papers relating to chemistry or collateral sciences.

Royal School of Mines.—Director, Sir Roderick IMPEY MURCHISON, Bart., K.C.B., F.R.S., &c.

During the Twenty-first Session, 1871-72, which will commence on the 2nd of October, the following COURSES of LECTURES and PRACTICAL DEMONSTRATIONS will be given:—

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The Fee for Students desirous of becoming Associates is £30 in one sum, on entrance, or two annual payments of £20, exclusive of the Laboratories.

Pupils are received in the Royal College of Chemistry (the Laboratory of the School), under the direction of Dr. Frankland, and in the Metallurgical Laboratory, under the direction of Dr. Percy.

Tickets to separate Courses of Lectures are issued at £3 and £4 each.

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Science Teachers are also admitted to the Lectures at reduced fees.

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THE CHEMICAL and TOXICOLOGICAL CLASS will meet as usual every Monday and Thursday evening, commencing October 2nd, at 8 p.m.

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The BOTANICAL and MATERIA MEDICA CLASS, every Wednesday and Saturday evening, commencing October 4th, at 8 p.m. The usual EXCURSIONS for the STUDY of PRACTICAL BOTANY will be continued every Saturday, until further notice, at 10 a.m.

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The Lectures will commence at the above Institution on Tuesday, October 3rd.

The Introductory Address will be delivered by Deputy Professor Pritchard, at 12 o'clock.

Anatomy, Physiology, and Pathology of the Horse—Professor Spooner.

Anatomy, Physiology, and Pathology of other Domesticated Animals—Professor Simonds.

Descriptive Anatomy, with Physiology—Deputy Professor Pritchard.

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August 25th, 1871.

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Any person will be eligible as a candidate who has passed an Examination qualifying him to register as a Medical Student, provided he has not previously completed a full year of medical study at a recognised Hospital.

Candidates are requested to call personally upon the Dean at the School, on Monday, Sept. 25th, betwen the hours of 3 and 5 p.m., and to bring with them a certificate of having passed the required preliminary Examination.

Further information as to the subjects of Examination, and the conditions under which the Scholarship and Exhibition will be held, may be obtained from Dr. Cheadle, the Dean, or from Mr. Knott, the Registrar, at the Hospital.

W. B. CHEADLE, M.D., Dean of the School.

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NATURAL PHILOSOPHY.	Prof. Balfour Stewart, LL.D., F.R.S. Prof. Thomas H. Core, M.A.
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LOGIC AND MENTAL AND MORAL PHILOSOPHY. POLITICAL ECONOMY.	Prof. W. Stanley Jevons, M.A., F.S.S., Fellow of University College, London.
JURISPRUDENCE AND LAW.	Prof. James Bryce, D.C.L., Fellow of Oriel College, Oxford.
CHEMISTRY.	Prof. H. E. Roscoe, B.A., Ph.D., F.R.S.
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ORIENTAL LANGUAGES.	Prof. T. Theodores.
MODERN LANGUAGES.	Prof. Theodores. Hermann Breymann, Ph.D.
MINERALOGY.	C. A. Burghardt, Ph.D.
FREE-HAND DRAWING.	William Walker.

The Session commences on the 2nd of October.

Prospectuses of the Day or Evening Classes, and of the Scholarships and Entrance Exhibitions tenable at the College, will be sent on application.

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FACULTY OF MEDICINE—SESSION 1871-72.

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Chemistry—Professor Brazier. 3 p.m. £3 3s.
Institutes of Medicine—Professor Ogilvie, M.D. 4 p.m. £3 3s.
Surgery—Professor Pirrie, C.M., F.R.S.E. 10 a.m. £3 3s.
Practice of Medicine—Professor Macrobin, M.D. 3 p.m. £3 3s.
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Medical Logic and Medical Jurisprudence—Professor Ogston M.D. 9 a.m. £3 3s.

SUMMER SESSION, commencing on the First Monday of May.

Botany—Professor Dickie, M.D. 9 a.m. £3 3s.
Materia Medica (100 Lectures)—Professor Harvey, M.D. 3 and 4 p.m. £3 3s.
Practical Anatomy and Demonstrations—Professor Struthers and the Demonstrator. 9 to 4, and 2 p.m. £2 2s.
Practical Chemistry—Professor Brazier. 10 a.m. £3 3s.
Zoology, with Comparative Anatomy—Professor Nicol. 11 a.m. £3 3s.

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Microscopical Manipulation; being the subject matter of a Course of Lectures delivered before the Quekett Microscopical Club, January—April, 1869. By W. T. SUFFOLK, F.R.M.S.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 616.

OBSERVATIONS ON CLEAN AND UNCLEAN SURFACES IN VOLTAIC ACTION.*

By THOMAS BLOXAM.
Lecturer on Chemistry, Cheltenham College.

IF a piece of amalgamated zinc is made to touch a piece of platinum in the presence of acidulated water, the well-known extraction of hydrogen bubbles takes place from the latter metal. Whilst trying a series of such experiments, and also some of a similar nature, I observed an unequal evolution of bubbles from some parts of the platinum plate, and accordingly submitted the matter to enquiry.

The first series of experiments had for their object to ascertain the amount of gas evolved in a given time from a zinc and platinum plate in contact.

Expt. 1. A tube graduated to 1 cubic inch was filled with water acidulated with ¼th of strong sulphuric acid; a strip of platinum as obtained from the apparatus makers was cut 7-in. long, ¼-in. wide; introduced into the tube which was then inverted upon a small plate of amalgamated zinc also standing in the same acid and water. The time at starting and at the termination was accurately recorded, as also the temperature and pressure throughout all the experiments. Time resulting from a *mean of many experiments* was 22 minutes.

Expt. 2. The strip cleaned by heating it in oil of vitriol, and thoroughly rinsing in distilled water, gave as a mean result. Time 14 minutes.

Expt. 3. The strip merely passed through the finger several times. Time 28 minutes.

It will be seen from these results that the platinum as it leaves the instrument makers is absolutely, so to speak, chemically dirty; but the mere contact with the hand is sufficient to materially modify the action.

The strip cleaned by oil of vitriol was dipped for a moment into solution of common salt, and again tried when the time required for collecting the cubic inch of hydrogen was nearly doubled.

The strip having been made dirty by touching, was ignited in the flame of a good Bunsen lamp for one minute, and then arranged in the cubic inch tube. The time required was fifteen minutes, thus showing that it had been in great measure cleaned, though hardly so satisfactorily as in the heating with oil of vitriol.

Expt. 4 was devoted to the action of copper negative plates in similar strips to the platinum; the mean results in these cases were that copper cleaned with nitric acid and washed in distilled water gave the cubic inch of hydrogen in twenty-one minutes. The strip passed through the fingers as in the platinum experiments. Time required 28½ minutes.

A strip of copper oxidised by heating in air furnished the hydrogen in ten minutes.

It would appear from these results, that copper behaves in a similar way as to cleanness of surface as platinum, and that the oxidised surface tends rather to facilitate the liberation of the hydrogen—perhaps from mechanical action, like platinised silver.

Expt. 5. Platinised silver, as obtained from the makers, arranged in the same way as the foregoing experiments, furnished the 1 cubic inch hydrogen in 2¼ minutes. A strip cleaned with oil of vitriol as usual, time 2¼ minutes. A strip made dirty by the fingers, time 3 minutes.

Hence it appears that the mechanical action of the platinum surface is of great importance, as has been well known, and that as received from the makers it is very considerably cleaner than the new platinum, because, probably, of its method of preparation.

It was also found that, comparing *smooth* with mechanically *roughened* surfaces of platinum, the latter furnished the hydrogen in two-thirds of the time taken by the former.

Expt. 6. A cell of Smee's battery was examined by the galvanometer, using in every case a regular strength of acid, the same wires and all conditions the same, when the following results were obtained:—

The negative plate not chemically cleaned, deflection = 52°.

Negative plate chemically cleaned, 57°.

Negative plate made dirty by fingers, 48°.

The platinum taken off the surface gave deflection 50°.

Here it appears, then, that the cleaning of the surface of the platinised silver materially diminishes the resistance due to the counter-current and polarisation.

The last series of experiments were directed to ascertain the influence of chemically clean surfaces upon electrolysis.

A voltameter, the electrodes of which were in their ordinary state, was attached to two cells of Bunsen's battery, and the mixed gases collected with all precaution. The time taken for 1 cubic inch was 2 minutes as a mean of many experiments.

The electrodes were then cleaned with hot oil of vitriol, the Bunsens freshly charged, and the 1 cubic inch of gases was furnished in 1¼ minutes; thus showing that electrolysis is materially affected by the state of cleanness of the electrodes at the time.

* Read before the British Association, Edinburgh Meeting, Section B.

ON THE DISSOCIATION OF MOLECULES BY HEAT.*

By C. R. C. TICHBORNE, F.C.S., M.R.I.A., &c.

DISSOCIATION has been, and is now, applied to phenomena somewhat distinct from ordinary decompositions.

Decomposition specifies that some molecular change has been consummated, whilst dissociation is used to convey a passive but present phenomenon. If this latter phenomenon is carried far enough, it must ultimately result in a rupture, and thus the phenomena of decomposition and dissociation are so intimately connected that they can hardly be investigated alone. We may familiarly illustrate the dissociation influence of heat to the stretching of a piece of india-rubber, in which the dissociative force of heat is here represented by the fingers; the particles (emblematic of molecules) of india-rubber are here held asunder by the force—but when removed the rubber regains its primitive construction. This stretch may be carried on to a wonderful extent, but there is a limit, for at last a point is attained at which the rubber breaks. Compound molecules exist as solids, liquids, and gases, providing that the temperature necessary to convert them into these physical modifications is not above the temperature at which their components are dissociated. Now we can easily conceive that a substance, A, may be of sufficient structural stability to pass through all the increasing vibratory action without dissociation of its component molecules, until it has passed through the solid, liquid, and far into the vaporous condition, whilst a substance, B, has, what I will call a thermanalytic point, or the point where the equilibrium is broken. If it lies below 100° C., we have dissociation in the liquid condition. A

* Read before the British Association, Edinburgh Meeting, Section B.

great number of compounds are dissociated above this point, *e.g.*, anomalous vapour density of chloride of ammonium; whilst those dissociated below 100° C. are less common and are much less easy of observation. I find that this dissociation influence is frequently at work when we little dream of it, particularly as regards solutions. I have lately made a well-known natural group of elements my study in connection with these phenomena, viz., the trioxides, aluminic, chromic, and ferric oxides, and find that, as might be inferred, all the compound molecules of these bases are more or less dissociated on heating their solutions. The ferric compounds are the most easily affected: thus the solution of their compounds, if pure, are almost colourless, the slight tinge being in most cases produced by the basic action of the water. By the cautious addition of dilute acid almost colourless solution will be procured (an excess of acid produces also a colouration). On the application of heat this solution becomes gradually darker and darker, until it becomes a dark reddish-brown fluid. If the water bears any considerable proportion to the salt a basic precipitate falls, before it has reached the boiling-point. The relative amount of the water is of the utmost importance in these phenomena, because its basic action lowers the thermanalytic point as I call it. The results of the dissociative influence of heat when a precipitate is not produced is the repartitioning of elements by which a basic and an acid salt is produced simultaneously in the same fluid by the dissociative influence of heat. If these experiments are carried on under pressure, or in the presence of a great excess of water, the dissociative influence is so great from the increased range of temperature that anhydrous oxide of iron can be produced, although in the presence of water.

The compounds of chromium are capable of dissociation in a similar manner, but, in this case, the point of dissociation is higher, and the phenomena are not quite so striking. A pure chromium salt, such as the sulphate when dissolved in water, gives a slightly basic solution from the action of the water. It is for this reason that the cautious addition of the "stylous" or acid molecule first of all makes it a purer blue—the original solution being violet, with a tinge of green; the addition of an alkali or the heating of the fluid produces a green solution; heated under pressure basic precipitates are procured; or, upon the addition of a large volume of boiling water, the precipitation of the basylous element is determined.

The aluminic molecules at first sight might be considered to differ from the other two, but such difference is only one of degree. They obey exactly the same rule, but, as the thermanalytic point is much higher, and, as there is no chromatic change to mark the dissociative influence of heat, it is difficult to discern this phenomenon. Under the influence of solutions boiling at an increased pressure of 11 or 12 atmospheres, I have not only procured basic salts but gelatinous alumina from the sulphate. As I have explained before, the same results may be obtained by increasing the basic condition of the solution by a very large volume of water. As the pressure retains the boiling-point of the water until we reach the thermanalytic point of the molecule, so the basic action of the water upon the stylous group lowers the thermanalytic point until we get it within the range of 100° C., so that the phenomenon can be exhibited at ordinary temperatures. There is no evidence of decomposition in solutions of any considerable strength on boiling, but if a very considerable proportion, 50,000 to 60,000 times its weight of water, is used to the amount of salt, a precipitate is produced at 100° C. This is best seen by passing a beam of electric light through the flask, as the precipitate produced from chloride of aluminium is almost optically invisible in daylight. A beam of electric light impinging upon the light flocculent precipitate at once reveals its existence. Most of the other precipitates can be observed by the eye, but they re-dissolve on cooling.

NOTES ON PHOTOMETRY.

By WILLIAM FOSTER.
Gas Examiner to the Metropolitan Board of Works.

IT occasionally happens that three or four experiments made at regular intervals during two hours of any one evening agree so closely that the gas appears to be of the same value each time an experiment is made. The very reverse, however, sometimes occurs, the numbers representing the illuminating power of the gas during the evening differing to the extent of two candles. The readiest explanation of such results as the latter is, that gas of varying quality has been passing through the main at different periods of the evening; and such a view of the case appears to be the only feasible one, when the experiments are known to have been made under similar conditions. By similar conditions it is implied that the gas has the same temperature, and is passing through the meter at an uniform rate, the barometer stationary, and the candles burning the same amount of sperm, or about the same, in each experiment. The first three conditions are obviously necessary. The latter does not at first sight appear to be so, owing to the correction made at the end of each experiment for any variability in the rate of consumption of the sperm. For most practical purposes, this correction for different rates of consumption of the sperm is sufficient—that is, when the candles are burning about the standard quantity. Still it is desirable to restrict its application within as narrow a limit as possible. The instructions of the Gas Referees are, that each experiment shall occupy ten minutes, and that the two candles employed shall consume forty grains of sperm (120 grains per hour). These conditions are rarely ever fulfilled; and it is to wide variations from this standard that my remarks are especially applicable. I have long ago questioned the value of observations taken with candles burning at low rates—say from 33 to 35 grains, and sometimes have not recorded them. The method adopted for arriving at a corrected result is to multiply the sum of the ten photometrical readings taken during the ten minutes by the number of grains of sperm consumed, and to divide this product by two, since two candles are used in the experiment. This process involves the theory that the light emitted from sperm is in simple proportion to the quantity consumed. For instance, *cæteris paribus*, the photometrical readings, based on the law that the intensity of lights is in the proportion of the squares of their distances from the point of measurement, are inversely as the consumption of the sperm. In other words, that any deficiency in the amount of sperm consumed is compensated by a higher reading in the photometer, and *vice versâ*, so that the product obtained by the multiplication of the readings and the quantity of sperm consumed, fairly represents the quality of the gas. This does not appear to me to be exactly true, at least not so far as ordinary practice is concerned. During last winter I had a parcel of candles, many of which gave not only low rates of consumption, but also very variable ones. Some of my results at that time were very high; and since then I have incidentally noticed that a low rate of consumption of sperm is in the majority of cases attended with a high number representing the illuminating power of the gas. In order to speak with confidence on this point, a large number of experiments have been made, the majority of which bear out all that I had previously noticed. They were made on consecutive evenings, extending over a week, and one experiment followed the other as quickly as circumstances would permit, the object being to notice whether any difference in the quality of the gas could be detected in such short intervals, when the conditions of the experiment were the same. The following were taken on three succeeding evenings, the same pair of candles being used for all the experiments made on any one evening. The method pursued was slightly different from that recommended by the Referees, and was as follows:—

During the time that the candles were burning in order to be ready for the first experiment, the quantity of gas was adjusted by the meter clock, the meter clock being used only for that purpose. Having the candles burning at the required rate, they were then placed on a balance, and, when the turning point was reached, a clock was immediately started by the right hand. A 40 grain weight was then placed in the balance on the side of the candles, the whole removed to the photometer, and the observations taken in the prescribed time. Towards the end of the 10 minutes the candles were taken out of the photometer, placed on the balance, and, the moment that the turning point was again reached, the clock on the right was instantly stopped. The time which had been required to consume 40 grains of sperm was then noted, and from this was calculated the consumption in 10 minutes. Thus, suppose 625 seconds have been required to burn 40 grains of sperm, then $625 : 40 :: 600 : x : x =$ the consumption of sperm in 600 seconds (10 minutes), in grains. This method in theory is the true one, the object being to weigh the candles on the two occasions under the same conditions so far as currents are concerned. Apart from this consideration, it has two special recommendations; there is no danger of losing any particles as there is when the candles are blown out, and in the second place the candles are immediately ready for another experiment. The experiments here given were made at a time when the pressure in the main was extremely regular, so much so that, having once obtained the gas passing at the required rate, scarcely any further adjustment was necessary.

July 6, 1871.

Time when an Experiment was commenced.	Sperm consumed in 10 minutes.	Illuminating power in candles.
8.25 p.m.	40·0	16·16
8.40 ,,	40·0	16·26
8.55 ,,	40·9	16·38
9.5 ,,	36·6	17·00
9.30 ,,	37·3	17·28
9.50 ,,	42·1	15·45

July 7, 1871.

8.25 p.m.	36·6	17·00
8.50 ,,	42·9	14·69
9.40 ,,	36·7	16·90
9.55 ,,	37·3	15·85

July 8, 1871.

8.30 p.m.	37·4	16·79
8.50 ,,	36·1	17·03
9.7 ,,	44·8	15·90
9.20 ,,	37·5	16·81
9.35 ,,	40·8	16·07
9.50 ,,	40·0	16·68

Experiments are not wanting which, at first sight, would appear to upset what these now given are intended to show; but such are not numerous. Besides, it must be borne in mind that throughout the whole there was the possibility of a difference in the quality of the gas. Hence the necessity of making a large number of experiments before any satisfactory conclusion could be arrived at. These results may be objected to on the ground that the use of the same candles for showing the effect of different rates of consumption is faulty at the outset, simply because the wicks are not adapted for such varying quantities. I may add that my experience is, that candles will of themselves vary to the extent of several grains. The candles here used were trimmed in order to obtain the different rates, but in no case could I detect anything objectionable in the character of the flame—they did not smoke. These results practically show that the tendency is to report gas above the truth when the rates of consumption are low; or that the amount of light emitted by sperm when burnt in the ordinary way is not simply proportional to the amount consumed, but that it is proportional + a certain quantity. I regret that I have not the means of storing gas of uniform quality, so as to be able by further experiments to arrive at some satisfactory numbers showing the law which regulates this increment to the illuminating power.

The photometer used is that known as Evan's improved form of the Bunsen. It is a rectangular box, 112 inches long, 6·5 inches broad, and about 11·5 inches high. The whole of the interior is lined with black velvet, except the greater portion of the roof, which is rounded, and made of blackened sheet copper. Midway in this box is a fixed diaphragm containing the waxed disc. The box is thus divided into two chambers of equal size, the capacity of one of them being about 4200 cubic inches. In one of these chambers, 50 inches distant from the waxed disc, is a fixed burner for the gas to be tested. In the other box is a sliding support for the candles, this support carrying an indicator which moves along a graduated scale on the outside of the machine. Each chamber is provided with a large door at the side. When an experiment is being conducted, the two chambers are closed during the entire time. The 40 grains of sperm burnt in 10 minutes require 126·2 grains of oxygen from external sources in order to convert the carbon and hydrogen into carbonic acid (carbonic anhydride) and water. The amount of atmospheric air containing this quantity of oxygen is 1768 cubic inches, or, nearly one-half the amount contained by the chamber in which the candles are placed. In addition to this a large quantity of air is always carried along with the spent vapours, by virtue of the current which they establish. Now what are the precautions taken for the supply of air, and the exit of the products of combustion and rarefied atmospheric air? Along the whole length of the under part of the machine is a narrow slit from $\frac{5}{16}$ to $\frac{4}{8}$ of an inch in breadth. Air cannot pass into the photometer through this slit without passing twice at right angles, thus avoiding all danger from draughts. This source of air is the only intentional one, and I imagine is sufficient to meet the requirements of both the gas and the candles. It is the means of exit of the heated vapours that appear to me to be faulty. Everyone accustomed to the use of the instrument must have noticed that nearly every time an experiment is made the numerical value of the photometrical readings gradually increases. This increase is such that where the first reading may be 8 the probability is that the 10th will be 9, or 9·5. This ought not to be, as it indicates that the candles do not give the same amount of light towards the end of an experiment that they do at the commencement. It is quite manifest that the gas does not suffer, at least not to the same extent, as the candles, otherwise the increasing value of the readings would not occur. My opinion is that the gas is tested under more uniform conditions than the candles, and for this reason: Immediately above the argand burner is a copper chimney, which at once takes away the heated gases and rarefied air, causing a proportionate influx of cold air through the slit below. The chamber containing the candles is also provided with a similar chimney, equally distant from the waxed disc, namely, 50 inches. The two chimneys, placed as described, not only maintain the symmetrical proportions of the instrument, but, if required, also permit two kinds of gas to be tested in it by burning one at each end. In addition to the two chimneys, one in each chamber, the eaves —so to speak—of the arched copper roof along their entire length admit of the exit of the heated vapours. The two slits, one on each side, are more complicated than the one at the bottom which supplies the air, and consequently the products of combustion of the candles have to pass by a very circuitous route before they can escape. There can be no question that the chimney placed above the gas-flame permits all the impurities to escape at once. The case of the candles is different. When testing 16-candle gas the two candles are then more than 30 inches distant from the chimney, so that its use for the purpose of ventilation is *nil*, or nearly so. The spent vapours and heated air must then escape promiscuously through the slits along the two edges of the roof, which appear to be in-

sufficient for the purpose. At first I was led to suppose that the increased value of the readings was due to an imperfect supply of atmospheric oxygen, owing to the narrowness of the slit supplying the air. But such a view is no longer tenable when one reflects that the supply to a flame eight times the size takes place through the same sized opening, without any apparent deterioration in the value of the flame. And yet there can be no doubt that it is owing to an imperfect supply of oxygen, although caused somewhat differently. The ingress of air is determined by the egress of the heated vapours, so that increasing opportunities of escape for the latter is simply causing a greater supply of the former. It therefore appears to me highly desirable that some form of chimney should be placed over the burning candles, so that they may be under conditions similar to those under which the gas is being tested in the adjoining chamber. If this chimney were constructed with a movable diaphragm, the draught would then be under control. As the instrument is at present worked, the candles are so near the roof that the need of this addition is shown by its very high temperature after the candles have been under it not more than 10 minutes.

104, Hill St., Peckham, London.
August 26, 1871.

ON RECENT INVESTIGATIONS AND APPLICATIONS OF EXPLOSIVE AGENTS.*

By F. A. ABEL, F.R.S., Treas. C.S.

(Continued from p. 104).

Numerous as have been the attempts during the last sixteen years to apply other explosive agents as substitutes for gunpowder in small-arms and even in artillery, no rival of the latter has yet thoroughly established any good claims to success as a propelling agent, except for sporting purposes. Nor does it appear probable, considering the difficulties which have to be encountered in sufficiently regulating the explosive action of gunpowder to adapt it to the heavy artillery of the present day, that even the apparently most controllable of other explosive bodies—gun-cotton—will ultimately prove susceptible of safe application in any larger artillery than field-guns. The ultimate failure of the repeated attempts made in Austria to apply gun-cotton to artillery and small-arms must not, however, be accepted as proof that no results of value are likely to be attained in this direction. A very decided advance had been made towards the successful employment of gun-cotton in field guns before the Government Committee on Gun-cotton ceased to exist in 1868; and if the experiments on this subject, which were then suspended, as well as those relating to the employment of gun-cotton in military small arms, have not been resumed, it is only because the Committee on Explosives, to whom the further investigation of these matters has been entrusted, has hitherto been fully occupied with the more immediately important investigations relating to gunpowder. Some considerable time was devoted by me, about three years ago, to the production of small-arm cartridges of compressed gun-cotton, suitable for the breech-loading arms of the service, and a system was already at that time pursued with considerable success, of regulating the rapidity of explosion of the material by its impregnation with minute quantities of a non-explosive and otherwise perfectly inert substance, which at the same time imparted considerable water-repellant properties to the cartridge. Experiments with cartridges prepared on this system will be resumed in due course; meanwhile a similiar method of treatment has been applied with great success to the production of sporting cartridges made of prepared and lightly compressed gun-cotton, by Messrs. Prentice, to whose energy and perseverance we are indebted for the firm establishment of gun-cotton as an important explosive agent.

Although gunpowder is still the only propelling agent susceptible of general application, it no longer enjoys a monopoly in connection with some equally important applications to naval, military, and industrial purposes. The very energetic action of potassium-chlorate upon readily oxidisable substances, and the great rapidity and violence of explosion of mixtures of that class, when compared with similar mixtures containing saltpetre, has given rise for many years past to repeated attempts, often renewed in the same directions, to apply that substance to the production of powerful substitutes for gunpowder. Mixtures of it with resin, powdered nut-galls, and other substances of vegetable nature or origin, have been suggested, and in some instances applied to a limited extent in directions where rapidity and violence of explosive action appear to present advantages, as in some kinds of blasting operations; even the old and well-known mixtures of the chlorate with potassium ferro- and ferri-cyanide and sugar, which, for many years past have been described in chemical handbooks as *white gunpowder*, and *German gunpowder*, have been more than once re-proposed of late, not merely as mining agents, but for use in firearms. The practical objection generally raised, and with reason, against mixtures of this class, that they are of detonating character, and consequently more or less dangerous to transport and handle, is always either met or forestalled by the proposal to keep the ingredients separate until the mixture is actually used, as the violent oxidising property of potassium-chlorate renders the production of powerfully explosive preparations possible by crude and rapidly-performed mixing operations, which would be altogether inadequate for the production of useful explosive mixtures with saltpetre. Such a proceeding is, however, inadmissible in naval and military service for several reasons; and the trouble which it would involve at the hands of miners using such preparations will probably always lead them to forego any advantages which might result from their employment, and either to adhere to gunpowder or to employ other materials supplied in the form in which they are actually to be used, even though considerable risk of accident may be incurred with these. Some of the preparations of this class, which, disguised by fancy names, occasionally find their way into miner's hands, are of so dangerous a character that it amounts to little short of deliberate criminality to endeavour to find a sale for such materials. Even mixtures consisting chiefly of potassium-chlorate and sulphur have been recently recommended as useful and safe mining agents. It need scarcely be said that a mixture of these substances is liable to explosion if submitted to a very slight friction or concussion; and although their sensitiveness to ignition may be very considerably reduced by the admixture of other substances, such mixtures will always be extremely liable to accidental explosion during the process of tamping, or unless handled with very great and constant care. A special application of the mixture of potassium-chlorate and sulphur, which merits brief notice, was made for war purposes in France at about the time of the late Exhibition. By converting the mixture into a paste, and then drying it, hard masses of the explosive agent can be produced, which are made to fit shells of lead, and afterwards completely enclosed in the metal by the operation of "spinning." A small-arm projectile is thus produced, which may be safely fired from a rifle, but which explodes with fearful violence even upon penetrating flesh, producing the most appalling wounds. It may be remembered that an account was published about a year ago of trials made in London upon horses with explosive bullets of this kind, the results of which established the success of the bullet as one of the most fearful destructive agents ever applied; but the agreement entered into long before the late war by the principal nations not to employ explosive bullets, has precluded any use being made of this ingenious mode of safely applying so highly detonating a mixture. It need hardly

* A Lecture delivered to the Members of the British Association at Edinburgh, August, 1871.

be stated that the conditions essential to safety, which can be readily fulfilled in enclosing a material of this kind in a leaden projectile, and firing it from a small-arm, do not bear comparison with those which arise when shells are fired from guns, even of small calibre.

The discovery of a more violent explosive agent than gunpowder, which may be employed as a charge for shells without any risk of accidental explosion resulting from the concussion to which they are exposed when the gun is fired, has been considered a desideratum for some years past. A few experiments were made by the late Committee on Gun-cotton upon the employment of that substance in shells, and spherical shells were safely fired from a mortar of 13 inches calibre, but disastrous results were obtained when this material was used as the charge of lead-coated and studded elongated projectiles fired from rifled guns. A few were safely fired, but, without any apparent alteration of conditions, others burst in the gun, and instead of simply indenting and scoring the bore, as would have been the case if a shell charged with powder had burst prematurely, one gun was rendered perfectly unserviceable by the violence of the explosion, and another was burst, the fragments being projected many hundred yards. Further systematic experiments have been continued for Government from time to time, with a view of discovering a safe and powerful explosive agent for shells. The relative disintegrating and scattering powers of a large number of explosive agents has been determined, in the first instance, by filling cast-iron shells of a particular calibre with the different materials; bursting these in a chamber of great strength, lined with wood; carefully collecting all fragments which could afterwards be found on the floor, and which could readily be extracted from the walls of the chambers, and determining the individual and total weights of these. In this way the extent to which the different shells were broken up by the explosion was correctly ascertained, and many explosive agents, for which great power had been claimed, but which proved to be not greatly superior to gunpowder, were eliminated, the most powerful being selected for further experiment. In illustration of the results thus arrived at, it may be stated that, when a shell weighing 16lbs. 1 oz., filled with powder, was burst, all the fragments were readily recovered; they amounted to eighteen, including the plug of the shell, and of these twelve weighed above 2 ozs. and under 2 lbs., and only one fragment weighed less than 1 oz. Upon bursting a shell of the same kind and weight, filled with a mixture of potassium-chlorate and potassium-picrate, 100 fragments were recovered, and these weighed altogether only 2 lbs. 6 ozs., nearly 14 lbs. of the shell having been dispersed in fragments too minute to be collected individually. Only one of the recovered fragments weighed more than 8 ounces, and ninety-three weighed less than 1 oz. It need scarcely be stated that such a disintegration of the shell would be far too considerable to render the latter of value as a destructive missile, but the result showed that a small proportion in weight of this potassium-picrate powder if it could be used in shells, would suffice to produce the desired breaking up of the shell and violent scattering of the fragments, and that, therefore, the thickness of metal of the shell, and its consequent destructive power, might be very considerably, increased. The chilled iron or Palliser shells, which, being of considerable thickness, hold comparatively small charges of powder, would obviously be rendered much more destructive as shells, by substituting for the powder-charges an explosive agent even considerably less violent in its action than the one just cited as an example.

The shell experiments above referred to were followed by a series of another kind, instituted in the first instance for the purpose of determining the relative susceptibility to explosion, by concussion or other mechanical causes, of gunpowder, and of the explosive agents selected from the results of previous experiments as most promising in their nature. These experiments consisted in interposing definite quantities of the materials between flat brass plates, placing them upon a rigid support, and allowing a weight to fall upon them from different heights. It soon became apparent that by varying the weight employed, and the surface and thickness of the layer of explosive material operated upon, some interesting and probably very useful results could be obtained. These experiments have therefore been considerably extended, and I trust shortly to have completed them sufficiently for publication of the results. It should be stated that some similar experiments were instituted by MM. Girard, Millot, and Vogt, during the siege of Paris last year, with mixtures of nitro-glycerine with a variety of solid and liquid substances of inert character, for the purpose of discovering the safest and most suitable media for the application and preservation of that explosive liquid. A communication made at about the same time to the French Academy of Sciences, by M. Champion, on the application to war-purposes of the mixture of nitro-glycerine and siliceous earth, well-known as dynamite, contains a statement to the effect that a shell filled with dynamite was safely fired from a gun at Mont Valérien, and the somewhat hasty conclusion is drawn from this single result that dynamite may be safely used in shells. More conclusively favourable results on the employment of nitro-glycerine in shells were obtained at Shoeburyness three years ago, when six shells (the entire number experimented with) were successfully fired, containing charges of a solid nitro-glycerine preparation, in which a mixture of pulped gun-cotton and saltpetre is made the vehicle for the employment of the liquid, and which therefore consists entirely of highly explosive material. The power of this substance had been previously demonstrated by numerous experiments, among which a charge less than one-third that of the full powder charge, mixed with sufficient sawdust to fill the chamber of a shell, burst the latter into ten times the number of fragments obtained with gunpowder. Promising as these results were, it was deemed advisable to seek for some other explosive agent than a nitro-glycerine preparation as the material for shell-charges, for two reasons—firstly, because the well-grounded confidence in the safety of nitro-glycerine and its preparations, essential to their employment in naval and military service, does not yet exist; and secondly, because the explosive force of these preparations, as illustrated by the one experimented with, appeared considerably to exceed that required in connection with the most general application of shells. Eventually, one of the salts of trinitro-phenic acid or picric acid was found to furnish an explosive mixture, which, as far as experiments have been carried, has proved to possess all the essential qualifications of a material applicable in the service as "shell-powder."

Picric acid, or carbazotic acid, as it was first called, is one of the earliest explosive substances of organic origin known, having been discovered as far back as 1788. It is produced by the action of nitric acid on a variety of organic substances. One of the earlier methods of obtaining it readily was by the action of nitric acid on indigo; but a comparatively abundant source of it was pointed out about thirteen years ago by Stenhouse, who readily produced it in large quantities by acting with nitric acid upon the resin *Xanthorrhœa saxtilis*, which was imported in considerable quantities from Botany Bay. Since the manufacture of phenol or carbolic acid from coal-tar has become developed, picric acid has been very extensively produced from that substance, and, as a cheap and brilliant yellow dye, has become an important article of commerce.

The acid itself does not explode, but burns quickly with a bright flame; its salts are all more or less powerfully explosive, and detonate when struck. The potassium salt is that most easily prepared, on account of its very slight solubility in water. It is also one of the most highly explosive. When mixed with oxidising agents, and especially with potassium-chlorate, it furnishes very powerful explosive materials; indeed, the chlorate mixture approaches nitro-

glycerine and gun-cotton nearly in violence of action than any other explosive agent produceable on a practical scale. This mixture is, however, so susceptible of detonation by friction or concussion as not merely to render its employment in shells impossible, but also to preclude its application to any purpose without the adoption of very special precautions. Other mixtures containing potassium-picrate have been made the subject of experiment, especially in Paris, where so-called "*poudre picrate*" or *poudre Designolle*, composed of potassium-chlorate, potassium-picrate, charcoal, and saltpetre, was prepared and experimented with upon a considerable scale about three years ago, as a substitute for gunpowder in firearms, and for other purposes. A fearful accident at a factory in Paris, where large quantities of the potassium-picrate were manufactured, led to the abandonment of these experiments; but there appears little doubt that picrate preparations were included among the agents of destruction employed by the Communists in the recent struggle at Paris. In the course of the experiments with shells containing various explosive substances, to which reference has just now been made, I was led to examine the properties of mixtures of ammonium-picrate with oxidising agents. This picric compound, which may be readily prepared upon a large scale, differs importantly in its behaviour, when exposed to heat, from the potassium-picrate, and from several other salts of this acid. When heated over a flame it fuses, sublimes, and burns without any tendency to explosion, while the potassium salt detonates under the same conditions. The latter also detonates somewhat violently when submitted to a moderate blow, whilst it is difficult to obtain evidence of detonation of the ammonium salt when struck sharply and repeatedly. A mixture of the potassium salt with saltpetre, though less susceptible to explosion by a slight blow than the chlorate mixture, is yet powerfully detonating; while a mixture of ammonium-picrate and saltpetre requires a violent blow to develop slight and partial detonation, and exhibits no tendency to ignition when submitted to very severe friction, which would at once explode the least sensitive of the explosive mixtures proposed as substitutes for powder. When flame is applied to particles of the mixture of saltpetre and the ammonium salt (to which I have given the distinctive name "picric powder,") the individual particles deflagrate with a hissing sound like that of the sudden escape of steam, and the deflagration has little or no tendency to spread to contiguous particles; but if the mixture is strongly confined, as in shells, it explodes violently, and exerts a destructive action, less formidable than that of gun-cotton, nitro-glycerine preparations, and potassium-picrate powder, but considerably greater than that of gunpowder, and therefore likely to prove a valuable substitute for the latter when greater violence of action is desired with shells of small capacity. A number of shells charged with picric powder have been fired without a single casualty from guns of different calibres, ranging to the 9-inch gun with the employment of a battering charge of 43 lbs. of R. L. G. powder. The safety of this substance is therefore considered sufficiently established to warrant the institution of thorough trials of its powers as an explosive agent for shells. It is a curious and important circumstance connected with this mixture, that though ammonium-picrate and potassium-nitrate undergo mutual decomposition, with production of the deliquescent ammonium-nitrate, if the two be *dissolved* together in water, the addition of sufficient water even thoroughly to moisten the mixture appears to induce no such change, as the latter, when dried again, has no increased tendency to absorb moisture from the air, which it scarcely does to the same extent as gunpowder. The picric powder is therefore quite equal in permanence to gunpowder, and as water may be used in incorporating the ingredients without any detriment to the stability of the mixture, its preparation is, at any rate, not more dangerous than the manufacture of gunpowder, and it may be safely submitted to the pressing and the granulating processes which are applied to the latter. As, moreover, the cost of picric powder, as compared to its power, is not considerable, this explosive agent is now recognised as susceptible of advantageous application to service purposes, provided its sufficient superiority over powder in regard to violence of action is satisfactorily established. It should be stated that, some time after experiments had been in progress with this material, at my instigation, it came to my notice that a Frenchman, M. Brugère, had been also experimenting with mixtures containing ammonium-picrate, and had suggested the employment of a saltpetre-mixture as a general substitute for gunpowder. It does not appear that any steps were taken in France at the time to submit this proposal to practical test; and there is good reason to believe that, as regards naval and military uses, the picric powder is hardly likely to offer special advantages, excepting as a safe material for use in shells.

The sucessful application of the remarkable explosive liquid, *nitro-glycerine*, which is primarily due to the ingenuity and untiring perseverance of Mr. Alfred Nobel, and which has been developed chiefly within the last seven years, presents several points of great interest. Though this liquid was discovered as far back as 1847, Nobel was the first to attempt its practical application. His original proposal was to apply it in conjunction with gunpowder (*i.e.* that of adding to the explosive force of the latter when used in shells, and for mining purposes, by impregnating the grains with the highly-explosive liquid) was not attended by any tangible success. He then appears to have proceeded upon the idea that by raising some small portion of a charge of nitro-glycerine to a temperature sufficiently high for its violent decomposition, he might succeed in producing an initiative explosion of that part of the charge, which would be transmitted to the remainder, and he was thus eventually led to employ a small charge of a detonating material, such as percussion-cap composition, to bring about the violent explosion of the liquid. This ingenious expedient, the precise *rationale* of which I had afterwards occasion to investigate in its general application to the development of the action of explosive substances, was the foundation of the successful employment of nitro-glycerine in mining operations. The existence of several most serious obstacles to the use of nitro-glycerine in its pure liquid condition was, however, soon practically demonstrated—in several instances, indeed, by most disastrous accidents, not easily effaced from memory, and the ingenuity of Mr. Nobel was consequently taxed to devise some method of promoting safety, and also certainty of action, in the employment of this powerful explosive agent. These ends were attained, at any rate to a great extent, by mixing nitro-glycerine with some solid substance of perfectly inert nature and of absorbent character, through the medium of which the liquid is susceptible of employment in a condition assimilating to that of other explosive agents in practical use. The vehicle employed by Nobel is a light siliceous earth, known in Germany as "kieselguhr," which may be mixed with about three times its weight of nitro-glycerine without becoming more than moist to the touch, and is therefore readily susceptible of manipulation as a solid material. This mixture, to which the name of *dynamite* was given by Nobel, is also specified to contain a small proportion of alkaline matter, to be added for the purpose of counteracting any tendency to the spontaneous development of free acid in the nitro-glycerine. Dynamite is as readily susceptible of explosion through the initiative agency of a detonating fuse as nitro-glycerine itself: and though it obviously cannot be so powerful an explosive agent as that substance when successfully applied in its undiluted condition, its destructive powers are still very greatly in excess of those of gunpowder; and this fact, together with the circumstance that, when properly applied, it does not need confinement for the development of its explosive force, and that it may be employed, with certain precautions, in damp blast-holes, without great

detriment to its action, has led to its gradually becoming very extensively applied to industrial purposes. Certain defects are inherent in the material, such as its losing its susceptiblity to detonation by the ordinary means at a low temperature, and the tendency of the nitro-glycerine to partial separation from the siliceous earth during transport and storage; but, in balancing its advantages against those of other explosive agents, the special defects of these have also to be taken into account; so that, provided the uniform stability of the material becomes firmly established, and the apprehensions as to its comparatively dangerous character, to which certain accidents have given rise, are allayed by further experience in its storage and use, and possibly by improvements in its manufacture, a high position may be assigned to dynamite among the most useful explosive agents of the present time.

Several other methods of applying nitro-glycerine as a destructive agent have been brought to public notice since Nobel's dynamite first attracted attention. Among the proposed preparations, the most recent, and one for which special power and virtues have been claimed, is the substance to which its inventor, M. Engels, has given the name of *lithofracteur*, and which contains in addition to nitro-glycerine and an absorbing medium of the description used in dynamite, some proportion of other explosive materials (such, for example, as the constituents of gunpowder). This substance, which appears to have been applied to a limited extent by the Prussians during the recent war, is of a plastic and almost pasty nature, and is employed in the form of rolls made up in paper, which absorbs some proportion of the nitro-glycerine. Its tendency to yield to pressure, even when suddenly applied, renders its accidental explosion by mechanical force a matter of very considerable difficulty, probably more so than in the case of dynamite. As regards its claims to superiority in point of safety and power over the latter and other similar preparations, they are still matters of dispute, and their validity can only be satisfactorily determined by careful comparative experiment.

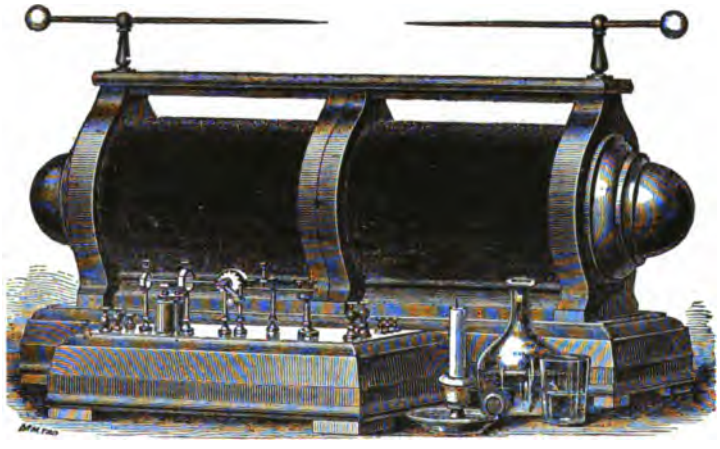
During the siege of Paris a dynamite factory was established in the outskirts of the city, and, in the absence of the particular siliceous earth which Nobel employs in its preparation, MM. Girard, Millot, and Vogt made a series of experiments, already alluded to in this lecture, with a view of ascertaining what substance could be best employed as a substitute for that absorbent material; their results indicated that, in addition to precipitated silica, the best media to be used are kaoline, tripoli, alumina, or sugar, the latter presenting the special feature that the nitro-glycerine can be rapidly separated from it by addition of water, a supposed advantage which Mr. Horsley had previously claimed for a mixture of nitro-glycerine and alum, but which may obviously constitute an important disadvantage in special applications of these mixtures —the tendency to separation of the liquid nitro-glycerine from them in wet blast-holes being a decided defect.

Sawdust and similar absorbent materials have also been used as vehicles for the application of nitro-glycerine, especially in America, under the name of *dualine*; and another preparation of nitro-glycerine, to which some years ago I gave the name *glyoxiline*, and with which some very effective blasting and engineering operations were carried out, consists, as already stated, of a mixture of gun-cotton pulp and saltpetre, which is saturated with nitro-glycerine. In the preparation of this material, one of the objections to the use of nitro-glycerine, arising out of its poisonous nature, and the readiness with which it is absorbed into the system, was, at any rate, partially met by providing the granules or masses of glyoxiline with a coating of some impermeable material. The injurious effects of nitro-glycerine upon the health of those constantly handling and employing it or its preparations, must unquestionably be frequently productive of series results, but are scarcely likely to interfere with their industrial applications, as it is well-known that risk of accident or of permanent injury to health will not deter men from persevering in the continuous use of means which may add to the productiveness of their labour.

(To be continued).

A LARGE INDUCTION COIL.

WE give herewith a woodcut taken from a photograph of an induction coil, built last summer by Mr. E. S. Ritchie, of Boston, for Dr. Morton, President of the Stevens Institute of Technology, about which the latter gentleman writes us very favourable accounts. He has, during the past winter, had occasion to use the instrument constantly, and to transport it to Washington, Baltimore, Philadelphia, New York, and elsewhere, and has never found it fail of the most satisfactory performance. The entire weight of the coil without the condenser, which is in the separate base shown in the front of the woodcut, is 166¼ lbs.



Its length from end to end of caps over primary coil is 40 inches, and its height to the upper surface of the long horizontal strip is 18¼ inches. The length of each of the secondary bobbins is 13 inches, and their external diameter is 9 inches.

The primary wire is 200 feet long, and 0·1655 of an inch or ¼ inch in diameter; its electrical resistance is 0·13 of an Ohm. The secondary wire is 234,100 feet, or about 44⅜ miles, long, 0·007 of an inch in diameter, and weighs 44¼ lbs.; its resistance is 404,000 Ohms. The condenser contains 325 square feet of coated surface.

The battery used with this coil consists of three glass jars, 10 inches diameter, and 12 inches high, into which are lowered by a windlass fifteen plates of zinc and fifteen of carbon, each 6×9 inches. The exciting liquid is the usual mixture of potassium bichromate and sulphuric acid. This battery has proved itself admirably efficient and reliable.

The performance of the coil is as follows:—With the above battery freshly charged and immersed 1 inch it gives freely sparks 21 inches long in air, and with the cascade battery of twenty coated panes, described by Prof. Morton in the CHEMICAL NEWS (vol. xvi., p. 149), it gives white Leyden jar sparks 14 inches long.

With a large Leyden jar its spark is reduced to 2¼ inches, but the light then afforded is sufficient to illuminate well a zoetrope disc 4 feet in diameter, and its sound is almost deafening.

Solid blocks of glass, 3 inches thick, can be pierced by the spark from this coil, and when the spark is repeated it takes a new path each time. When used to illuminate a Gassiot's cascade, a secondary condenser or cascade battery (as described by Prof. Morton in the article alluded to above) being in circuit, the effect is so brilliant as to allow of the use of this illustration in the largest public buildings. The entire coil is divided in the middle, so that it can be coupled for quantity effects.

EXAMINATION OF SAMPLES OF CHLORAL HYDRATE.*

By M. M. PATTISON MUIR, F.C.S. Glasgow.

As chloral hydrate has of late become a somewhat extensively used medicine, and as the purity of the compounds used in pharmacy is a matter affecting the interests of many, there was most properly noted in the circular of the British Pharmaceutical Conference among the subjects for investigation—"The Purity of the Chloral Hydrate of Trade."

Chloral hydrate, by the action of caustic alkalies, is broken up into chloroform, and a formiate of the metal of the alkali employed; thus with caustic potash—

$$C_2HCl_3O + KHO = CHCl_3 + KCOHO.$$

In this investigation I have endeavoured, in the case of each sample examined, to answer the following questions:—

(1). Does the sample yield, upon treatment with caustic alkali, such a percentage of chloroform as might reasonably be expected?

(2). Does the sample contain any, or any appreciable amount of, chloral alcoholate?

And, further, with regard to commercial chloral hydrate generally, I have endeavoured to show which samples, judging from their appearance and physical characters, are to be regarded as purest. And, lastly, I have sought to give an answer to the general question—Is the chloral hydrate now sold by druggists of a fair average purity?

Pure chloral hydrate is easily soluble in water; upon heating, it dissolves, leaving a perfectly clear fluid. Chloral alcoholate, on the other hand, heated with water, melts, but does not dissolve, and solidifies again, beneath the water, upon cooling. Pure chloral hydrate, again, with strong sulphuric acid, floats on the surface of the acid, and, on heating, slowly melts, forming a clear layer of liquid with the heavier acid beneath, with no browning or discolouring of the acid; chloral alcoholate colours the acid brown upon being treated in a similar manner. With nitric acid (25 per cent strength), pure chloral hydrate gives, on applying heat, little or no reaction; alcoholate gives violent reaction, red fumes being given off.† The boiling-point of pure chloral hydrate is 96°—98° C.; of alcoholate, 115° C.

The process adopted for estimating the $CHCl_3$ yielded by each sample was that described by K. O. Müller (Chemical News, vol. xxiii., p. 113), viz.:—Into a tube, graduated from the bottom in c.c., was introduced a certain known quantity of the sample; pure caustic potash solution of medium strength was then added, and, after standing ten to fifteen minutes, the tube and its contents were thoroughly shaken until all the chloral hydrate was dissolved. The tube being securely corked was then set aside, and, after three to four hours, the number of c.c. of chloroform which settled to the bottom of the tube was read off; this was multiplied by the sp. gr. of chloroform —the figure taken being 1·5—and so was obtained the percentage of chloroform yielded by the sample under examination. The results are embodied in the following table:—

Sample. Appearance.	Behaviour on heating with water.	Behaviour on heating with strong sulphuric acid.	Behaviour on heating with dilute nitric acid.	Boiling-point.	Percentage of $CHCl_3$ on treating with KHO.
1. Large pieces, crystalline, slightly moist to the touch, strong pungent odour.	Easily dissolved, nothing crystallised out on cooling.	Melted on the surface, no discolouring of the acid.	Dissolved, no fumes given off.	97°	67·70
2. Semi-transparent, not perfectly pure white, slightly moist, crystalline.	Do.	Do.	Do.	96·5°—97°	65·99
3. White cakes, no definite crystalline structure, falling easily to powder, moist to the touch.	Do.	Do.	Do.	96°—96·5°	68·07
4. Very pure white small non-transparent pieces, crystalline.	Do.	Do.	Do.	97°—97·5°	68·15
5. Had white cakes non-transparent and non-crystalline, seemingly dry.	Do.	Do.	Do.	97·5°—98°	70·83
6. Small round transparent pieces, no needle-shaped crystals, *very slightly* moist.	Do.	Do.	Do.	96·5°—97°	71·02
7. Small non-transparent pieces with very little crystalline structure.	Do.	Do.	Do.	97°—98°	67·71
8. Tolerably large pieces, crystalline, much more moist than any others.	Do.	Do.	Do.	96°—96·5°	60·98

Theoretically, pure chloral hydrate should yield, on treatment with caustic alkali, 72·20 per cent of $CHCl_3$.

From these results I would conclude—

(1). Generally, the samples were of a fair average quality.

(2). None of them, so far as I may infer from my experiments, contained chloral alcoholate.

(3). The purest was that sold in small transparent pieces, nearly dry to the touch, exhibiting no needle-shaped crystals, and not having a *very* pungent odour.

(4). The samples varied in the amount of chloroform yielded by each, chiefly, it seems to me, on account of the time they had stood in the shop—chloral hydrate easily

* Paper read before the British Pharmaceutical Conference, Edinburgh Meeting.

† *Year-Book of Pharmacy*, 1870, pp. 112—113.

absorbing moisture, and the stoppers being frequently removed, those samples which had been some time in the shop must necessarily be more moist than those newly received from the maker. This view is confirmed by the amount of chloroform yielded by Samples 5 and 6, which were obtained from wholesale dealers, and had not, therefore, been exposed to the varying fortune likely to meet them while standing on the shelves of a druggist's shop. Generally, these experiments show that the chloral hydrate now sold by druggists is of fair average quality.

SCHOOLS OF CHEMISTRY.

The following information arrived too late to appear in our "Students Number":—

Berners College of Chemistry, 44, Berners Street, W.—Conducted by Professor E. V. Gardner, F.E.S., &c. The course of study in each instance is directed to the express want of the pupil, or according to choice. A course embraces thirty or thirty-five lectures, of a practical character, of about one and a half hours' duration. The usual practice of a Laboratory can be obtained with every convenience, under the immediate direction and guidance of Professor E. V. Gardner. An evening class in practical chemistry for laboratory work, meeting for two hours twice each week during one term; fee, two guineas, to be paid in advance.

Ladies' Medical College.—The Ladies Medical College, established by the Female Medical Society in order to teach to educated women the theory and practice of Midwifery and the accessory branches of medicine. *President.*—Lord Shaftesbury. *Hon. Sec.*—Dr. James Edmunds. The eighth annual session will commence on October 2nd, 1871, and extend to April, 1872, with a vacation of two weeks at Christmas. The lectures will occupy the afternoons of the Mondays, Tuesdays, Wednesdays, and Fridays, from 3 o'clock till 5. *Elementary Materia Medica.* (Teachership now vacant.) *Elementary Chemistry.*—Mr. J. A. R. Newlands. Fee for two sessions' attendance upon the lectures on midwifery, anatomy, and physiology, medical science, and hygiene, £10 10s. Fee for each of the extra courses, one session, £1 1s.; two sessions, £1 11s. 6d. Further details as to the objects and operations of the society, and prospectuses of the college, may be obtained by letter to the Lady Secretary, 164, Great Portland Street, W.; or from the Hon. Sec., 4, Fitzroy Square, W.

The Hartley Institution, Southampton.—*Lecturer on Chemistry.*—A. W. Bickerton, F.C.S., A.R.S.M. *Assistant.*—G. Gray. *Junior Class.*—A Course of about thirty Lectures is given during each term. On Mondays, Wednesdays, and Fridays, from 10 till 11 a.m. *Senior Class.*—Mondays and Thursdays, at 11 a.m. The Junior Class is devoted to a general outline of the *theory* of chemistry, illustrated by experiments and demonstrations. In the Senior Class students are taken through the applications of Chemistry to the Arts, Analysis, &c., receiving at the same time practical instruction in the Laboratory. Fees for the Senior Class, £2 2s.; for the Junior, £3 3s. per term. The Laboratory is open daily from 10 till 4, except on Saturdays, when it closes at 1, for instructive and practical work. Fees may be known on application. Evening Classes in theoretical and practical chemistry, are held during the winter session.

CORRESPONDENCE.

ALUM IN BREAD.

To the Editor of the Chemical News.

Sir,—I was surprised the other day on reading the report of a lecture on this subject, delivered by Dr. Carter Moffat before the Chemists' and Druggists' Association, at Glasgow, in January last, to find him stating that alum and logwood gave a *dark red* colour, which is directly at variance with the well-known characteristics of the mixture of those substances, as given in every work on chemistry and dyeing to my knowledge for upwards of 40 years, and until some higher authority can be adduced to support such a statement I must decline to accept it, having invariably found that a deep purple or violet blue is the result.

Dr. Moffat's experiments were made at night time, but I fancy if he examined his specimens in the morning when the colour became fully developed, he must have found that all those which *really contained alum* went blue, as of course they ought to do. Surely there must be a mistake somewhere.—I am, &c.,

John Horsley.

The Laboratory, Cheltenham,
September 9, 1871.

"THE ONENESS OF MATTER."

To the Editor of the Chemical News.

Sir,—Professor William Thomson has given to the world an hypothesis by which he accounts for the origin of life on this earth. On this hypothesis we are to consider the endless variety of plants and animals derived from a few simple forms received meteorically. It is indeed a "prodigious step." I conceive as possible that *all* matter —simple or compound (so called)—is constituted of *one element* under different molecular forces. The step from one simple form of matter to all known and unknown compounds is less prodigious than that assumed by Sir W. Thomson. Yet the two cases are somewhat parallel.

Compounds have, in general, no resemblance in properties to the elements which constitute them. If a force, or forces, can cause the union of two elements, and the compound formed is no likeness of its constituents, may not a force, or forces, act on *one* matter or element, and the resultant bear no likeness to the original matter! See how unlike carbon as charcoal, and carbon as the diamond are, and yet they are one matter. By combustion both give carbonic acid gas.

Thus all the 65 elements, so viewed, would be the same *matter* actually, but each under different forces; the forces engaged so operating as to give to each different properties. And it would be easy to rise from simple to compound matter; a compound being formed by a uniting force between two or more such differently operated upon portions of elemental matter. On this hypothesis, if all forces were withdrawn so as to leave all the ultimate particles in contact, matter would be reduced to simplicity. Finally, in relation to this subject—to use Professor Thomson's words—"All I maintain is, that it is not unscientific."—I am, &c.,

Chas. Thos. Kingzett.

Putney.

THE GUN-COTTON EXPLOSION.

To the Editor of the Chemical News.

Sir,—Having carefully considered the evidence, as reported in the public papers, it appears to me that the most probable cause of the explosion of gun-cotton at Stowmarket has not been suggested by any of the witnesses examined.

I believe it to have arisen from the effect of gradually accumulated heat from the vaporising action of the unusually heated magazine on damp gun-cotton.

When this substance was first introduced I experimented extensively on its manufacture, and soon found the importance of perfect neutralisation of acid, and of peculiar care in drying.

With rapid ventilation, at a high temperature—over 300° —it could be dried without danger, but at a temperature even as low as 100° ignition would take place most

readily if the moisture, as soon as vaporised, were not removed by ventilation.

Evidence has been given of the malicious introduction of sulphuric acid, but it has not been shown that, although it may promote decomposition, it has, in the case of the discs examined, increased their liability to ignition. It is, however, probable that the sulphuric acid may have caused the absorption of moisture, which, on the heating of the magazine during the hot weather, may have been vaporised, and thus the temperature within the gun-cotton may have gone on increasing until the explosive point was attained. In the course of evidence it did appear that the month of August had been recognised as peculiarly liable to explosions.

In the *Chemical Gazette* some time since, I called attention to the fact that I had repeatedly ignited fibrous peat, shredded into small portions, by placing it, while damp, in a partially closed vessel in a position where the bottom of the vessel could not have attained a higher temperature than 120° F.

I could always prevent the ignition by stirring the mass sufficiently to allow of the dissipation of the vapour formed within the mass of fibrous matters.

Having regard to these facts, I applied the principles suggested with great success to several practical purposes; and I took every opportunity of cautioning persons using drying processes on hydro-carbonaceous bodies, whether fibrous or otherwise.

I predicted disastrous explosions which occurred in two gunpowder manufactories in this neighbourhood. Want of attention to the caution given issued in the closing of both of the factories.

If ordinary hydrocarbons, such as peat, sawdust, hemp, starch, &c., be liable to ignition at such low temperatures, what may not be expected of similar substances when associated with other matters greatly increasing their tendency to ignition.

The manufacture of gun-cotton may, no doubt, be safely carried on by carefully ventilating the driers, using every precaution suggested by the knowledge of these facts, such as the employment of only a low temperature, with an amount of ventilation largely in excess of ordinary requirement to prevent danger from changes of atmospheric conditions.

It becomes, however, a very series question whether the use of gun-cotton may be maintained with the knowledge of the extreme danger arising from its becoming accidentally moistened, and its consequent liability to heating up to the point of ignition by the ordinary increase of atmospheric temperature. This difficulty may possibly be overcome by waterproofing the perfectly dried gun-cotton. I have succeeded in waterproofing gunpowder, but I have not had the opportunity of experimenting on gun-cotton. I do not anticipate any great difficulty in so doing, especially as in the form of discs it is greatly facilitated.—I am, &c.,

ROBERT OXLAND, F.C.S.

Compton Gifford, Plymouth,
September 8, 1871,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 13, 1871.

From the protocol of the meeting of this Society we quote the following:—Prof. A. W. Hofmann exhibited to the members a series of photographic pictures representing views of the new chemical laboratory built at Pesth (Hungary), and sent to the *savant* just named by Dr. von Than. It appears, from the brief explanatory paragraph devoted to this subject, that this new laboratory is in every respect an excellent, yet somewhat improved, copy of the celebrated Berlin laboratory. All members of the Chemical Society above alluded to are politely requested to send in their *carte de visite*, signed with their names, to Dr. C. Scheibler, 24, Alexandrinen Strasse, Berlin, in order to complete the photographic album of the Society. All books, pamphlets, &c., intended to be presented to this Society are requested to be sent to the same address.

The number above mentioned contains the following original papers and memoirs:—

Application of Polarised Light for Determining the value of the Cinchona Barks.—O. Hesse.—This paper is in reality a critical review of a paper published by Dr. J. E. de Vry (*Journ. Pharm. Soc.*, No. 53, p. 1, 1871), "On the Adaptability of the Strong Action most of the Cinchona Alkaloids possess upon Polarised Light for the purpose of Estimating the Value of the Cinchona Barks." The author of this paper points out the great difficulties which, in various respects, stand in the way of such an application, and reminds, among other matters, that, beside quinine and cinchonine, the barks alluded to contain, as first stated by Dr. De Vry's discoveries, other alkaloids, the action of which, as regards polarised light, is almost unknown.

Chemical Studies on the Alkaloids of Opium.—O. Hesse.—This lengthy essay treats, in the first place on the mode of preparation, and next on the properties, of some of the more recently discovered alkaloids of opium, viz.:—Cryptopine, $C_{21}H_{23}NO_5$, fuses at 217°, readily soluble in chloroform, not so in ether, difficultly so in alcohol, has a strongly alkaline reaction, and forms, with acids, salts, most of which crystalise; protopine, $C_{20}H_{19}NO_5$, fuses at 202°, is almost insoluble in ether, but difficultly soluble in alcohol; laudanosine, $C_{21}H_{27}NO_4$, crystalline in prismatic shape, readily soluble in alcohol and ether, fuses at 89°, and forms with HI a very difficultly soluble salt; hydrocotarnine, $C_{12}H_{15}NO_3$, fuses at 50°, is crystalline, readily soluble in ether and alcohol, and exhibits, with strong sulphuric acid, the same reaction as does narcotine. The author calls attention, at length, to the peculiar reactions which these and other (codeine, codamine, and laudanine) opium alkaloids exhibit with pure and impure (that is, containing a trace of oxide of iron) strong sulphuric acid at 20° and at 150°. These reactions are so marked by the peculiar colourations which ensue that these bodies may be thereby readily recognised and detected. While space forbids us to give here the full details, we quote, as instances, the following:—

	Pure acid dissolves—		Acid containing iron dissolves—	
	At 20°.	At 150°.	At 20°.	At 150°.
Codeine	Colourless.	Dirty green.	Blue.	Dirty green.
Codamine	Colourless.	Dirty red to violet.	Deep greenish blue.	Deep violet.
Laudanine	Very faint rose-red.	Dirty violet-red.	Brownish red akin to solution of nitrate of cobalt.	At first green, next deep violet.

Contribution to our knowledge on Benzyl-Ether.—F. Sintenis.—The contents of this paper treat mainly on the behaviour of benzyl-ether with the haloids. By the direct action of chlorine, bromine, &c., upon the ether just named, either at the ordinary temperature or by the aid of heat, no substitution products are formed; while, as regards benzyl-phenyl-ether, substitution products are only formed under peculiar conditions. When benzyl-methyl-ether or benzyl-ethyl-ether are treated with dry chlorine at the ordinary temperature, there is formed oil of bitter almonds, C_6H_5COH, and chlor-methyl, chlor-ethyl, and benzyl-ethyl-ether yields, under these conditions, C_6H_4ClCOH and chlorethyl. The benzyl-phenyl-ether—

$$C_6H_5CH_2OC_6H_5,$$

does not exhibit, with the haloids, any stability in forming substitution products.

Miscellaneous Notices.—L. Henry.—This lengthy paper, filled with a large number of extensive formulæ, is divided into the following sections:—On the isomerism of the glycerine derivatives of the formula $(C_3H_5)X_3$. On various glycerine derivatives—bichloro-iodhydrine, $(C_3H_5)Cl_2I$; chloro-bromo-iodhydrine, $(C_3H_5)ClBr.I$; chloro-brom-nitrin, $(C_3H_5)ClBr(NO_3)$; chloro-nitro-sulphuric acid glycerine, $(C_3H_5)Cl(NO_3)(HSO_4)$; bichloracetin, $(C_3H_5)Cl_2(C_2H_3O_2)$; bromo-diethylin of glycerine, $(C_3H_5)Br(C_2H_5O)_2$. Preparation of dichlorhydrine. On glyceric acid-ether, $(C_3H_5O)(HO)_2(C_2H_5O)$; on glycolic acid diethyl-ether.

Brom-Benzo-Nitrile.—C. Engler.—This essay treats on—Brom-benzoic acid ether, $C_6H_4Br.CO.OC_2H_5$, a colourless, highly refractive fluid, boiling at 259°. Brom-benzamide, $C_6H_4Br.CO.NH_2$, a crystalline solid body, readily soluble in alcohol, difficultly so in cold water, and fusing at 150°. Brom-benzo-nitrile, $C_6H_4Br.CN$, a solid substance, exhibiting crystalline structure, fuses at 38°, boils at 225°, and is readily soluble in alcohol and ether.

Action of Sodium Amalgam upon Oxalic Ether.—S. Friedlander.—This paper is mainly a critical review of the statements made by A. Eghis (see CHEMICAL NEWS, vol. xxiv., p. 34) in reference to this subject, especially as regards the question of glycolinic and glycolic acid.

Researches made in the Chemical Laboratory of Lund (Sweden) University.—C. W. Blomstrand.—This memoir is divided into the following sections, of which only the titles are given, because, notwithstanding the intrinsic scientific value of this communication, the large number of formulæ render useful abstraction impossible:—Derivatives from luteo- and roseo-cobaltiac-iodo sulphate.—J. M. Krok. The sulphites of copper and silver and double salts thereof.—N. Svensson. On some of the sulpho-ethers of ethylen.—F. Ewerlöf.

Further Researches on the so-called Fore-Run (First Distillate) of the Spirit Distilleries.—A. Kekulé.—This memoir contains a detailed account of the labours of several chemists, among whom Dr. J. Weinzierl, Dr. Zincke, and others, on the constituents of the fore-run, especially in the case of the distillation of the fermented beet-root molasses. It appears, from what is here communicated, that the aldehyde, paraldehyde, metaldehyde, and acetal found in the fore-run are due to the action of small quantities of nitric, hyponitric, and nitrous acids, which are formed during the fermentation in small quantity.

Oxidation of Ketons.—A. Popoff.—The author describes at length the mode of preparation of methyl-phenyl-keton, boiling at 200°, and the mode of its oxidation. The result of that process is that benzoic and carbonic acids are formed—

$$C_6H_5-\cdot-CO-\cdot-CH_3+3O=C_6H_5-\cdot-CO_2H+CO_2+H_2O.$$

Ethyl-phenyl-keton, boiling at from 208° to 212°, soluble in water, and combinable with bisulphite of soda, yields, by oxidation, benzoic and acetic acids—

$$C_6H_5-\cdot-CO-\cdot-C_2H_5+3O=C_6H_5-\cdot-CO_2H+C_2H_4O_2.$$

Researches on the Uric Acid Group.—M. Nencki.—This paper contains, in the first place, a discussion on the constitution of the uric acid, and on the probability of synthetically preparing uric acid from sulpho-urea. In this direction, the author has experimented by mixing together sulpho-urea along with alloxan and alcoholic solution of sulphurous acid, and exposing that mixture for five hours in a sealed tube to a temperature of 100°. The result is that sulpho-pseudo-uric acid is formed, which, after having been purified, was found to consist of $N_4C_5O_5SH_6$; it is formed according to the following formula:—

$$N_2C_4O_3H_4+N_2CSH_6=N_4C_5O_5SH_6+O.$$

This body is insoluble in water and ammonia, difficultly soluble in hydrochloric, but more readily so in hydrobromic and sulphuric acids, from which solutions it is precipitated by water; also soluble in caustic alkali solutions. The removal of the sulphur from this substance did not succeed. The author treats at considerable length on the products of decomposition of this substance.

Naphthol Compounds.—J. Grabowski.—This paper is divided into the following sections:—Oxalic acid and naphthol; chloride of phthalic acid and naphthol; pyromellitic acid and naphthol.

Products of the Reduction of Silicic Acid Ether and some of its Derivatives.—A. Ladenburg.—This lengthy essay does not admit of useful abstraction.

Monochlor-Crotonic Acid.—C. Sarnow.—The acid alluded to has been prepared by the author by causing zinc-dust to act, along with water, upon trichlor-crotonic acid, allowed to flow drop by drop into the water containing the zinc. The aqueous solution of monochlor-crotonate of zinc thus obtained is readily decomposed by hydrochloric acid, and the monochlor-crotonic acid purified by re-crystallising it from hot water, wherein this acid is readily soluble, as is also the case with alcohol and ether. Monochlor-crotonic acid, $C_4H_5ClO_2$, fuses at 94°, boils at 206°, and acts, when in contact with the skin, as an epispastic. This paper further contains chapters on monochlor-crotonid ($C_4H_4ClO.Cl$), monochlor-crotonamid ($C_4H_4ClO.NH_2$).

The Betain of the Phosphorus Series.—A. H. Meyer.—This valuable scientific paper is not suited for abstraction, owing to the large number of formulæ required.

Some of the Derivatives of Piperidine.—J. W. Brühl.—This memoir is divided into the following sections:—Introduction, containing a review of the labours of Cahours and Hofmann on this subject; action of ethen-bromide upon piperidine; action of ethen-bromide upon ethen-dipiperidyl-diamine.

Methylisation of the Phenyl Group in Aniline.—Drs. A. W. Hofmann and C. A. Martius.—This very lengthy and exhaustive monograph, full of formulæ, contains, besides a lengthy introduction, the following sections:—Dimethyl-aniline; dimethyl-toluidine; dimethyl-xylidine; dimethyl-cumidine; dimethyl-cymidine.

Nature of the Sea-Water along the Coast of Bohuslän (Sweden).—Prof. J. L. Ekman.—From this lengthy memoir we quote the most interesting point—viz., that, as regards the quantity of salt contained in the sea-water on the west coast of Sweden, there is greater difference than for any other now known sea. The coast alluded to is, on the one hand, watered by the North Sea, and on the other by the Baltic. In the more northerly part the water at the surface contains rather less than 2 per cent salt, at 60 feet depth 2·5 per cent, at 90 feet depth 3 per cent; in the more southerly portion the discrepancies are greater, but at 600 feet depth 3·5 per cent salt is met with. The average quantity of salt of the oceans is 3·44 per cent; while in the Atlantic, from the equator to from 55° to 60° N. latitude, the quantity of salt in the surface-water is 3·606 per cent, and at depths of from 500 to 10,000 feet 3·578.

Annalen der Physik und Chemie, von Poggendorff, No. 5, 1871.

The original papers and memoirs of this number relating to chemistry and allied sciences are the following:—

Apparatus for Determining the Resistance which Atmospheric Air Exerts against Moving Bodies.—K. H. Schellbach.—A memoir illustrated by engravings.

Third Instalment of the Essay on the Friction which Particles of Gases exert upon each other.—O. E. Meyer.—An algebraico-physical treatise.

On Fluorescence.—E. Lommel.—An optico-mathematical essay.

Researches on the Electrophor.—W. von Bezold.—This lengthy memoir, illustrated by engravings, is, as regards its contents, strictly an algebraico-physical paper.

Description of a New Thermo-Galvanic Battery of Great Force.—Dr. A. von Waltenhofen.—Illustrated by engravings essentially required for the proper understanding of this apparatus.

Leidenfrost's Phenomenon.—R. Colley.

Experimental Proof of the Existence of Air in Water.—A. Andersohn.—The description of a complicated contrivance for experimentally proving a fact which is readily exhibited by the aid of an air-pump.

Stereoscopic Phenomenon produced by Dispersion.—F. Kohlrausch.—Illustrated by diagrams.

Simple means for Increasing the Deviation or Dispersion of a Ray of Light.—F. Kohlrausch.

Appendix to a Paper published in a former volume of this periodical, "On the Abnormal Dispersion Exhibited by Bodies Coloured on the Surface."—A. Kundt.

Melting of Lead Shot when Fired against an Iron Target.—E. Hagenbach.—After referring to a former paper on this subject, the author mainly states that Dr. A. Socin had exhibited to him balls extracted from wounds caused in the late war, some of which balls exhibited signs of fusion, thereby leading to the inference that, on the impact of the balls with bones, a great deal of heat is generated.

Observations on Thomsen's Experiments on the Specific Heat of Aqueous Solutions.—A. Wüllner.

No. 6, 1871.

This number contains the following original papers relating to chemistry and allied sciences:—

Purity of the Surface of Films of Albumen and Tannin for Photographic Use.—C. Schultz-Sellack.

Studies on the Colouration of the so-called Smoky Quartz.—Dr. A. Forster.—An optico-crystallographical essay; but the main result of chemical investigation leads to the inference that the smoky colour is due to the presence in the quartz of a substance containing organic nitrogen and carbon.

Priority of the Discovery of the Relation existing between the Second Chief Axiom of the Mechanical Theory of Heat and the Principle of Least Action.—L. Boltzmann.

Contribution to our knowledge on Chlorophyl and some of its Derivatives.—E. Gerland and N. W. P. Rauwenhoff.—This paper, a spectroscopico-chemical essay, is illustrated by a series of engravings.

On the Rebound of Elastic Bodies, and the Determination of the Time Elapsing between each Rebound.—H. Schneebeli.

Refraction of Light Exhibited by Fuchsine.—C. Christiansen.—Optico-physical essay illustrated by engravings.

Second Essay on Abnormal Dispersion.—A. Kundt.

Improved Excitation Method for Electrical Machines.—W. Musaeus.

Newly Improved Holtz's Machine Fitted with Double Discs turning in opposite directions, whereby twice as much Electricity can be Generated.—W. Musaeus.—The contents of these two papers, however interesting in a scientific point of view, do not admit of any useful abstraction.

Earthquake of Cosenza, October 4th, 1871.—G. vom Rath.—This essay contains the detailed description of everything which bears, in a geographico-physical and geological aspect, on this catastrophe, which destroyed a portion of Calabria (Sicily).

Chromate of Chrom-Oxychloride.—E. Zettnow.—The author describes at great length the mode of preparation of three specimens, compounds obtained by the action of strong sulphuric acid upon chlorochromate of potassa. The samples designated A and B are compounds the formula of which is $Cr_2Cl_4O+4CrO_3$; in 100 parts—chromic acid, 60·42; chlorine, 21·45; chromium, 15·71; oxygen, 2·42. The sample designated C has the formula $Cr_{10}Cl_{20}O_3+22CrO_3$; in 100 parts—chromic acid, 55·88; chlorine, 27·05; chromium, 15·85; oxygen, 1·22.

La Revue des Scientifique de la France et de l'Etranger, August 19, 1871.

This number does not contain any original papers relating to chemistry, but contains the continuation and end of the very interesting lecture on the—

Influence of Heat upon Animals.—Dr. C. Bernard.

August 26, 1871.

This number does not contain any original papers bearing upon chemistry, but we meet here with a very excellent series of lectures on—

Respiration and the Renewal of Air in the Lungs.—Dr. Gréhant.—Illustrated by woodcuts.

September 2, 1871.

This number does not contain any original papers relating to chemistry or allied sciences.

Bureau Scientifique Central Neérlandais à Harlem, August 15, 1871.

Under this title, Dr. E. H. von Baumhauer has sent us a circular, the contents of which agree essentially with what has been already communicated to our readers on this subject (see CHEMICAL NEWS, vol. xxiv., p. 97). We only add here that Messrs. Williams and Norgate, of Henrietta Street, Covent Garden, London, have been appointed as agents for the Bureau, which, as regards the United Kingdom, is in communication with all the most important of the scientific institutions and societies existing therein.

Le Moniteur des Produits Chimiques pour l'Industrie, les Sciences et les Arts et du Matériel de ces Industrie Publié par une Société de Chimistes et d'Industriels, August 25, 1871.

In addition to several papers of economico-political and politico-industrial importance, this number contains the following original matter relating to chemistry:—

Pigments and Dyes known to and used by the Ancients.—E. Rousset.—The first portion of an essay on this subject. From the contents it appears that the author's primary object is to prove that the ancients were not so ignorant in industrial matters as is commonly supposed to be the case. Among the white pigments, they were acquainted with white-lead, which, according to Pliny, was prepared especially at Rhodes. As black pigments, various kinds of charcoal and soot were used by the Ancients, the same as nowadays; while they dyed animal skins black with nutgalls and sulphate of iron. By their acquaintance with the use of various kinds of ochre, and by mixing these, either with each other in various proportions, or with black pigments, brown pigments of various shades were obtained. Under the name of Alexandria blue, the Ancients (the author includes in that term the Ancient Egyptians, as well as Greeks and Romans) largely used and prepared a pigment containing oxide of copper, and they also were acquainted with a pigment containing cobalt; while indigo was not unknown to them, but not used for dyeing, their blue-dyed fabrics being obtained by the use of pastel-wood, *Isatis tinctoria*.

Improved Process of Soda Manufacture.—M. Swager.—By the joint aid of highly superheated steam and red-heat, the author decomposes the double chloride of aluminium and sodium, previously fused. The result is the formation of aluminate of soda and hydrochloric acid; the latter is condensed, the former, treated with carbonic acid, yields carbonate of soda and alumina.

Biography.—E. Rousset.—Under this heading the author here publishes another instalment of the life and labours of the late M. Payen.

Les Mondes, August 24, 1871.

This number contains the following original matter relating to chemistry and allied sciences:—

Use of a Screw Propeller fitted to Sailing Vessels.—E. Martin.—The author proposes to fit sailing ships with a screw propeller, to be set into motion by the movement of the ship while sailing, the object being to employ the mechanical power thus obtained for the purpose more especially of imparting movement to a magneto-electrical apparatus, with the view of giving to sailing vessels the advantage of electro-magnetic light on deck at nights, instead of the use of oil lamps now applied, for indicating the ship's course and presence to other vessels.

Elasticity of Caoutchouc.—E. Villari.—An algebraico-physical essay on the elasticity by stretching, and on the change of volume of caoutchouc.

Formation of a New Volcano in Sicily.—Rev. F. Moigno.—The author states that, on a mountain situated near Bivona (district of Girgenti), a crater has been opened.

Very Hard Cement.—Rev. F. Moigno.—Some repairs being required to the stone steps leading to a garden, the mason used Portland cement mixed with finely-divided cast- and wrought-iron filings and broken-up borings, instead of with sand. The result has been that the mass has become so hard as not to admit of being broken either with hammer or pickaxe.

Discovery of Coals in Norway.—Rev. F. Moigno.—In the island of Andöe, off the coast of the province of Nordland, borings have been executed which have led to the discovery of seven seams of coal, varying in thickness from 0·076 to 0·508 metre.

NOTES AND QUERIES.

Lute for Nitric Acid—Test for Nitric Acid.—Can any of your readers inform me what is the best and cheapest lute for use in the manufacture of nitric acid? I have used plaster of paris, but do not find it to answer very well, and think there must be a better luting material in general use. What is the best and simplest tests for any nitrous compounds in sulphuric acid? Aniline and sulphate of aniline have lately been suggested, but are these found to be the most exact in their test? What is the cheapest method of destroying both colour and smell in palm oils on a large or manufacturing scale?—CHEMICUS.

Logwood Test for Alum.—(Reply to B. F. Munn.)—This test was first proposed by Mr. Horsely, of Cheltenham, and has been thoroughly tried by Dr. R. Carter Moffat, who came to the conclusion that the best method of applying this test is as follows:—120 grms. of chips of logwood are digested in 8 ozs. of methylated spirits for eighteen hours, then filtered. This solution, when brought into contact with bread or flour free from alum, produced a pale yellow or straw colour, but a dark red when alum is present. The process is, therefore, simply to apply, to bread or flour suspected to contain alum, a portion of the alcoholic solution of logwood prepared as mentioned.

TO CORRESPONDENTS.

*** We cordially thank those gentlemen who so kindly acceded to our request, in sending us the necessary information respecting the Chemical and Medical Schools for our Students' Number.

T. W.—You will find full particulars about Zeiodelite in an English edition of Wagner's "Chemical Technology," which will shortly be published by Messrs. J. and A. Churchill.

R. W.—The pamphlet never arrived; we shall be glad to receive one.

A. E. Tucker.—Your object is unattainable.

J. W. Taylor.—We have often quoted titles of books on the subject. Consult the Index to the CHEMICAL NEWS, or our "Answers to Correspondents."

BOOKS RECEIVED.

Annual Report of the City of New York for the years 1869 and 1870.

Annual Report of the Board of Regents of the Smithsonian Institution for 1869. Washington.

New Remedies, a Quarterly Retrospect of Therapeutics, Pharmacy and allied subjects. Edited by Horatio C. Wood, jun., M.D. New York: William Wood and Co.

Lecture on the Analysis of Coal-Gas. By Henry Letheby, M.B., M.A., &c. Delivered before the British Association of Gas-Managers. London: William B. King.

NOTICE TO AMERICAN SUBSCRIBERS.

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The Session 1871—1872 will commence on the 2nd of October, when the Laboratories will re-open at 10 a.m. for Instruction in Practical Chemistry as applied to Pharmacy, Medicine, Analysis, &c. Pupils can enter at any period. Terms moderate.

THE CHEMICAL and TOXICOLOGICAL CLASS will meet as usual every Monday and Thursday evening, commencing October 2nd, at 8 p.m.

The LATIN CLASS for the reading of Physicians' Prescriptions, Cæsar's Commentaries, &c., every Tuesday and Friday evening, commencing October 3rd, at 8 p.m.

The BOTANICAL and MATERIA MEDICA CLASS, every Wednesday and Saturday evening, commencing October 4th, at 8 p.m. The usual EXCURSIONS for the STUDY of PRACTICAL BOTANY will be continued every Saturday, until further notice, at 10 a.m.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 617.

ANALYSIS OF PITTICITE, FROM REDRUTH, CORNWALL.

By Professor A. H. CHURCH, M.A.

CAREFULLY selected homogeneous portions of a fine specimen of this mineral from Cornwall were submitted to analysis, after having remained a year or more in my cabinet. They evidently still contained a considerable amount of hygroscopic water.

Water lost at 100° C.	8·76
,, lost at 175°	7·53
,, retained at 175°	8·63
Ferric oxide	32·54
Arsenic pentoxide	33·99
Phosphorus pentoxide	1·27
Sulphur trioxide	7·28
	100·00

Regarding the water lost at 100° as non-essential or accidental, we may re-calculate the above numbers as follows:—

Water	17·71
Ferric oxide	35·67
Arsenic pentoxide	37·25
Phosphorus pentoxide	1·39
Sulphur trioxide	7·98
	100·00

I fear that these numbers throw no fresh light upon the constitution of this very variable mineral, and that no satisfactory formula can be deduced from them. Yet there can be little question but that they belong to pitticite, a species which has not, I believe, hitherto been definitely ascertained to be British. One peculiarity of the Cornish specimens consists in the high proportion of arsenic pentoxide which they contain, a proportion which is greater than that in this mineral as derived from any other recorded locality. But, on the other hand, the Cornish pitticite shows a smaller quantity of ferric oxide than the other analysed specimens. It does not appear that phosphorus pentoxide has been previously detected in this mineral. I ought to add that the Cornish mineral was straw to ochre-yellow in colour, subreniform and massive in form, and in great part opaque. The softest, palest, and most homogeneous portions were selected in preparing the sample for analysis. It is not improbable that the darker and less opaque portions would have shown a higher percentage of iron.

CONTRIBUTIONS TO THE HISTORY OF THE PHOSPHORUS CHLORIDES.*

By T. E. THORPE, Ph.D., F.R.S.E.

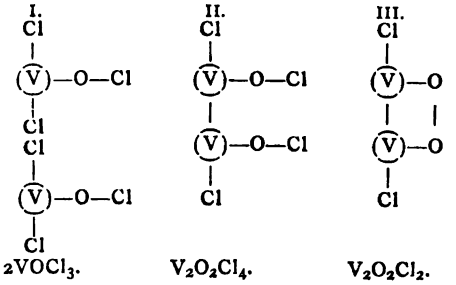
I. *On the Reduction of Phosphoryl Trichloride.*

IN his first memoir on vanadium, Dr. Roscoe described a series of oxychlorides obtained from vanadyl trichloride by the action of reducing agents. When the vapour of vanadyl trichloride is passed, together with hydrogen, through a heated tube, a bright grass-green crystalline sublimate of vanadyl dichloride, $VOCl_2$, is produced in the anterior portion of the tube; afterwards, a layer of vanadyl monochloride, VOCl, is deposited as an exceedingly light flocculent brown powder; whilst, at the extreme end of the tube, beautiful bronze-coloured plates of the divanadyl monochloride, V_2O_2Cl, are formed, which have the appearance of mosaic gold. In this memoir, Dr. Roscoe clearly pointed out the intimate analogy which exists between the compounds of vanadium and those of phosphorus, arsenic, antimony, and nitrogen, and, in his subsequent researches on this subject, he has so far elaborated this view of its chemical relationship, that there is no longer room to doubt that vanadium is virtually a member of the trivalent group of elements.

It must be confessed, however, that the triatomic nature of vanadium is not very apparent in the oxychlorides derived from the vanadyl trichloride if the simplest formulæ derived from their analysis be retained; but, if these formulæ be doubled, the difficulty at once vanishes. The supposition, that these oxychlorides possess a greater molecular weight than the vanadyl trichloride, may derive some support from the fact of the change of physical state which accompanies their formation, the lower oxychlorides being all solid. Beyond this, I am not aware that any fact is known to establish such an assumption, unless it be the coincidence between the atomic volume of the vanadyl trichloride and that of the vanadyl dichloride with the formula doubled—

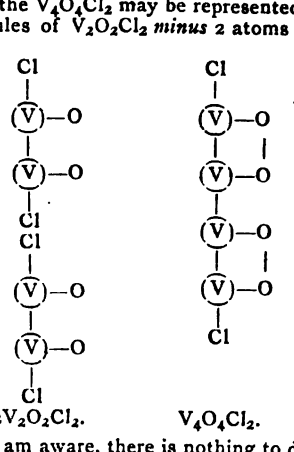
	Specific gravity.	Atomic weight.	Atomic volume.
$VOCl_3$ ..	1·83	173·8	95·0
$V_2O_2Cl_4$ ..	2·88	276·6	96·0

According to this view, the formulæ of these oxychlorides and their relation to the vanadyl trichoride would be thus graphically represented—



$2VOCl_3$. $V_2O_2Cl_4$. $V_2O_2Cl_2$.

And, just as the $V_2O_2Cl_4$ is formed by the juxtaposition of 2 molecules of $VOCl_3$ *minus* 2 atoms of chlorine, so, in like manner, the $V_4O_4Cl_2$ may be represented as derived from 2 molecules of $V_2O_2Cl_2$ *minus* 2 atoms of chlorine, thus—



$2V_2O_2Cl_2$. $V_4O_4Cl_2$.

So far as I am aware, there is nothing to disprove such a method of representation; it has, at least, the merit of preserving the triatomic nature of vanadium in these compounds, and shows in a simple manner their relation to the vanadyl trichloride.

* Read before the British Association, Edinburgh Meeting, Section B.

Assuming, then, that the triatomic nature of vanadium is established, analogy points to the existence of other oxychlorides among the trivalent group than those at present known to us. To fulfil the relationship we ought to have $TOCl_3$ $T_2O_2Cl_4$, $T_2O_2Cl_2$, and $T_4O_4Cl_2$, where T represents a member of the triatomic group of elements. The following table represents these analogies so far as they are complete:—

$VOCl_3$	—	$POCl_3$	—	$SbSCl_3$
$V_2O_2Cl_4$	$N_2O_2Cl_4$	—	—	—
$V_2O_2Cl_2$	$N_2O_2Cl_2$	—	$As_2O_2Cl_2$*	$Sb_2O_2Cl_2$†
$V_4O_4Cl_2$	—	—	—	—

The $V_2O_2Cl_4$ was also prepared by Roscoe by heating $VOCl_3$ in a sealed tube with fragments of metallic zinc to a temperature above the boiling-point of mercury; in this way the compound was obtained in quantity, and it was easily freed from a small quantity of adhering $VOCl_3$ by heating to 130° C. in a current of dry carbon dioxide. I have attempted to repeat this reaction with phosphoryl trichloride. A quantity of the pure liquid was sealed up together with zinc filings in a tube, and heated to about 400°. The zinc was slowly acted upon, and a transparent glassy mass was formed at the bottom of the tube; no evolution of gas occurred on opening the tube. The small quantity of liquid remaining was submitted to distillation; it commenced to boil at about 80°, and the thermometer gradually rose to 105°, by which time the whole of the liquid had passed over. This behaviour appeared to indicate the presence of phosphorus trichloride, PCl_3, and a few drops of the liquid, decomposed by water, yielded the reactions of phosphorous acid. The quantity was too small to admit of fractional distillation, even if the perfect separation of the two liquids had been practicable by this method; accordingly, three portions of the distillate were weighed out for determination of the chlorine, total phosphorus, and amount of phosphorus yielding phosphoric acid on decomposition with water.

1. *Determination of Chlorine.*—The weighed quantity of liquid was decomposed by water in a stoppered bottle, a quantity of nitric acid added, and the chlorine precipitated with silver nitrate.

0·6032 grm. gave 1·7764 AgCl and 0·0075 Ag.

Cl found.	Calculated	
	For $POCl_3$.	For PCl_3.
73·21 per cent	69·36	77·43

2. *Determination of Total Phosphorus.*—The mixed chlorides were decomposed by water in the manner above described, nitric acid added, and the liquid concentrated. The fluid was then made strongly alkaline by ammonia, and the phosphorus precipitated as the magnesium ammonium compound.

1·3343 grms. gave 1·0077 magnesium pyrophosphate, or 21·09 per cent P.

3. *Determination of the Phosphorus existing as Phosphoryl Chloride yielding Phosphoric Acid on Decomposition with Water.*—The bulb containing the weighed portion was broken under water, and ammonia and "magnesia-mixture" immediately added.

1·3965 grms. gave 0·5174 magnesium pyrophosphate, or 10·58 per cent P; equivalent to 52·35 per cent $POCl_3$.

These numbers almost exactly correspond to a mixture containing equivalent quantities of $POCl_3$ and PCl_3; such a mixture would give—

		Found.
Cl	73·17	73·21
Total P	21·32	21·09
P giving PO_4H_3 ..	10·66	10·58

The vitreous mass remaining in the tube fused on gently heating, and was decomposed; it was probably a combination of one of the above chlorides with zinc chloride, possibly the $ZnCl_2+POCl_3$ already described by Casselmann, mixed with zinc oxide or zinc oxychoride.

The action of zinc at a high temperature on phosphoryl trichloride is therefore sensibly different from the action of this metal on the corresponding vanadium compound; in the former case, the reaction is attended with abstraction of oxygen; in the latter, with abstraction of chlorine.

II. *Note on the Preparation of Phosphorus Sulphochloride.*

This compound was first prepared by Serullas, who obtained it by the action of sulphuretted hydrogen upon the pentachloride of phosphorus—

$$PCl_5+H_2S=2HCl+PSCl_3.$$

This reaction, however, affords only an impure product. Baudrimont states that this compound is more easily prepared by the action of pentachloride of phosphorus on antimony trisulphide—

$$3PCl_5+Sb_2S_3=2SbCl_3+3PSCl_3.$$

It has long been known that phosphoryl trichloride may be easily obtained in a state of complete purity, by the action of pentachloride of phosphorus on phosphoric anhydride—

$$P_2O_5+3PCl_5=5POCl_3.$$

It occurred to me to try whether the sulphochloride might not be produced by the analogous reaction with phosphorus pentasulphide—

$$P_2S_5+3PCl_5=5PSCl_3.$$

The materials, mixed in this proportion, were heated in a sealed tube to about 150°; in a few minutes, combination was quickly effected, and the entire contents of the tube were transformed into colourless phosphorus sulphochloride—a mobile liquid, boiling constantly at 126° at 770 m.m. Bar. Its vapour is extremely irritating, but when diluted with air it has an aromatic odour, reminding one of that of the raspberry.

* Wallace's chlorarsenic acid.
† Schaeffer.

ON RECENT INVESTIGATIONS AND APPLICATIONS OF EXPLOSIVE AGENTS.*

By F. A. ABEL, F.R.S., Treas. C.S.

(Continued from p. 129).

THE meeting of the British Association in 1862 marks the period when gun-cotton, which fell into disfavour in England and France within two years of its discovery by Schönbein in 1846, again attracted public attention in this country. A committee was appointed at the Cambridge meeting to report on the system of manufacturing and applying gun-cotton, which had been elaborated in Austria by Baron von Lenk; and, early in the year following Her Majesty's Government received from that of Austria a confidential communication of the full details respecting von Lenk's improvements. I was at once called upon, in the spring of 1863, to investigate practically and scientifically the merits of the several modifications which had been imported into the original process of manufacture, as laid down by Schönbein; and, early in the year following, a committee was appointed by the Secretary of State for War, under the presidency of Sir Edward Sabine (and including several members of the British Association Committee), with instructions "to investigate the properties of gun-cotton as a substitute for gunpowder." The continuance of the chemical and manufacturing portion of these investigations being left in my hands, as a member of that committee, the results arrived at with regard to to the production and composition of gun-cotton, the causes to which the uncertain stability hitherto exhibited by it were to be ascribed, and the extent to which Von Lenk's improvements had removed or reduced these, were communicated by me from time to time to the Committee and the Royal Society. Some very searching experiments were made upon a considerable scale, for the Com-

* A Lecture delivered to the Members of the British Association at Edinburgh, August, 1871.

mittee, with gun-cotton manufactured according to Von Lenk's process, at Waltham Abbey, with a view to ascertain whether the requisite confidence could be placed in its keeping qualities, and the results were so far satisfactory, that the Committee, in the Report which they submitted in 1868, were enabled to state that strong evidence had been afforded of the stability of the material when properly manufactured; though they considered that further experience was required to determine this important point with sufficient certainty to justify a general adoption of gun-cotton for military service. The various samples of gun-cotton upon which the Committee based their conclusions in 1868 have been preserved to the present day, under the same conditions; recent inspection has shown them to be quite unaltered. A further experience of more than three years has, therefore, been acquired, favourable to the stability of the material, most of which was manufactured eight and seven years ago. With regard to the methods of preparing gun-cotton for mining purposes, and for artillery and small-arms, devised by Von Lenk, which have been described in detail to the British Association at former meetings, the results arrived at by the Committee did not sufficiently bear out the expectations which at first were entertained of the practical value of those methods, to warrant any decisive conclusion of a favourable nature being arrived at; and it was obvious that much remained to be done to obtain proper control over the explosive power of gun-cotton, and to render it really susceptible of being safely and beneficially substituted for gunpowder.

In examining the results obtained when gun-cotton was fired under pressure (*i.e.* in confined spaces), and observing the very limited and uncertain extent to which the explosive violence of the material was subjected to regulation, under those circumstances, by the methods of twisting and winding, and other expedients employed by Von Lenk to give compactness to a charge of the fibrous material, I was led to believe that there would be much greater prospect of attaining the desired results if gun-cotton could be converted into a form readily susceptible of treatment by compression, so as to furnish perfectly homogeneous masses of required form and density,—resembling gunpowder, in fact, in their physical character. This object was attained by submitting the gun-cotton fibre to the pulping process applied in the preparations of rags and fibres for paper-making, and afterwards converting the pulp into sheets or moulded masses, to which perfect compactness and a high density could be given without difficulty, by means of well-known mechanical appliances.

This modification of the method of preparing gun-cotton, when applied to the preparation not only of mining charges, but also of cartridges for small-arms and for artillery of small calibre, soon furnished decisive and very promising results. The experiments hitherto instituted with compressed gun-cotton in small arms and artillery have been only of preliminary nature, as already stated; but the substitution of charges of compressed gun-cotton for blasting and mining operations, in place of the gun-cotton rope hitherto employed, was not only at once productive of greatly improved results on account of the considerable reduction effected in the size of the charges of a given weight, but also imparted to the material a character of safety (in its storage, and all manipulations with it) which it did not hitherto possess, as the masses of compressed gun-cotton cannot be made to explode by accidental ignition unless they are very strongly confined. The advantages resulting from the application of the pulping process to gun-cotton were, however, not limited to the improvements effected in its efficiency as an explosive agent, but extended, with a degree of importance scarcely at first anticipated, to the properties of the material, specially in regard to stability, and to its manufacture, which was speedily quite revolutionised thereby. Thus, instead of the raw cotton of high quality and long staple, which it had been necessary to use in carrying out the Austrian system, any description of cotton could be employed, and the waste cuttings from spinning-machines (such as are used for cleaning machinery) proved to be as suitable as cotton in any other form.

The purification of the raw cotton from seed and from other matters foreign to cellulose, which are contained in the hollow fibres, constituted a most important preliminary operation in the Austrian process. Even by a searching treatment with alkali, and careful washing, these impurities were never thoroughly removed; and the products of somewhat indefinite and comparatively unstable nature, produced by the action of the acids upon these traces of organic impurities, and occasionally remaining in the finished gun-cotton, were clearly shown in the investigations which I carried out on the stability of this substance, to be the starting-point in any change which gun-cotton might sustain by long exposure to elevated temperatures. The cotton-waste now used in making gun-cotton has undergone so thorough a purification by the various manufacturing processes through which it has passed, that, while no further preliminary purification is requisite, the finished gun-cotton obtained from it is practically free from the impurities just referred to.

The cotton having been treated with the mixed nitric and sulphuric acids, and the greater portion of the acids afterwards separated, the subsequent processes of purification and preparation differ entirely from those pursued in Von Lenk's system. The purifying processes prescribed by the latter, and demonstrated experimentally to be absolutely essential in dealing with gun-cotton in the form of fibre, consisted in very long-continued washing (extending over several weeks) in running water, and subsequent treatment with alkali. The capillarity of the long fibres constituted the great obstacle to rapid purification, the displacement of the acid from the interior of these being obviously a very slow operation. In the present system of manufacture the gun-cotton is rinsed two or three times in a large volume of water, the latter being extracted as completely as possible between each rinsing by means of centrifugal apparatus; it is then transferred to a rag-engine of the kind ordinarily used in producing pulp for paper-making. Here it is not only reduced to the state of fine division necessary for its subsequent conversion into homogeneous compressed masses, but it also undergoes at the same time a most searching purification, which is continued in a still more complete manner in the next operation, the pulp being transferred to what is technically called a poaching-engine, where it is beaten about so as to remain uniformly suspended in a large volume of warm water, continuously renewed, and rendered slightly alkaline at the close of the operation. This washing is carried on uninterruptedly until samples of the material under treatment have satisfactorily sustained a very severe heat-test, and generally lasts about forty-eight hours. At least 10 cwts. of gun-cotton are washed at one time in the poaching-machine; in this way an exceedingly intimate mixture of the products of many dipping operations is obtained, and any fluctuations in the composition of the gun-cotton are thus made to counterbalance each other, much greater uniformity in the explosive power of the product being obviously secured than was previously attainable. When the gun-cotton pulp is completely purified it is converted into compact masses of the desired forms and density by a preliminary moulding process, and subsequent application of hydraulic pressure ranging from 4 to 6 tons upon the square inch. During the whole of these manufacturing operations the gun-cotton is wet, and therefore absolutely uninflammable. Even when it leaves the presses it still contains about 20 per cent of water, and is so perfectly safe in this condition that slabs of it may be cut up by means of circular or band saws, revolving very rapidly, and holes drilled in it by drilling machines, or even by means of a red-hot iron. In this damp and incombustible condition the compressed gun-cotton may be stored in water-tight cases for any length of time; the final drying of the masses is carried on ver

rapidly and safely upon hot plates, which are freely open to the air at the sides.

Numerous experiments, on a considerable scale, have been made with a view to thoroughly test the safety of compressed gun-cotton. Deal boxes, filled with the material in the ordinary way in which it is stored, and securely closed, have been arranged in piles, and the contents of a box in the centre of the pile have been ignited by means of a fuse. In another experiment one of the inner boxes of a pile has been surrounded by highly combustible material, aud the latter inflamed, so as to envelope the box in fire. In all instances the contents of the one box have ultimately burnt, but without even shattering the latter, and the large volume of flame produced for a few moments sometimes penetrated to the interior of another box in the heap, causing its contents to inflame in like manner but in no instance was an explosion produced. Those boxes the contents of which were intact were removed from the pile without incurring any danger, although the inflamed boxes were still burning. Closed boxes, filled with compressed gun-cotton, have been fired at with a Martini-Henry rifle from a distance of 100 yards; in some instances the box and contents were perforated by the bullet without igniting the gun-cotton; in other instances the contents were inflamed, but no explosion occurred. Numerous other practical proofs have been obtained of the safety of compressed gun-cotton as compared with gunpowder, and with gun-cotton in the comparatively loose and open condition.

When the Austrian improvements in the preparation of gun-cotton were communicated to the British Association in 1864, great stress was laid upon the fact that the proper development of its explosive force could only be effected by confining the material in receptacles of considerable strength, as in shells, in firmly tamped boreholes, or very strong cases of wood and metal. In attempts made by our Royal Engineers in the autumn of 1863 to apply gun-cotton to the demolition of the works at Corfu, the operations failed, in the majority of instances, to furnish any satisfactory results, evidently on account of deficiency in strength of the cases, specially constructed for this purpose, in which the charges of gun-cotton were supplied by the Austrian Government. These, and other unfavourable results, warranted the conclusion that gun-cotton could not be advantageously applied as a substitute for gunpowder in connection with military operations of mining and demolition which it is desirable to be able to accomplish hastily, and for which consequently few men and appliances, and little preparation, should be needed.

(To be continued).

ON THE

ACTION OF HEAT ON PROTOPLASMIC LIFE DRIED ON IN COTTON FABRICS.

By F. CRACE CALVERT, F.R.S.

The papers which I have previously published on the action of heat on animalcule life having been almost entirely of a purely scientific character, I propose in this to give a series of experiments which have a direct bearing on the question of the disinfection of fabrics and wearing apparel by the application of heated stoves, with the object of destroying contagion or animalcule life.

To carry out these views, a piece of ordinary grey calico was treated chemically, and washed until free from any sizing material, and dried; this prepared cloth was then steeped in a solution of putrid albumen containing abundance of animalcule life, wrung out, and dried at the natural temperature; it was then cut into small pieces, 5 centimetres square. Each of the pieces was then folded in two, rolled up, and introduced into a small strong glass tube of 6 centimetres in length and 9 millimetres in diameter; each tube was then hermetically sealed at the blowpipe.

These specimens of calico were prepared on the 8th of August, and on the 9th thirty-five small pieces were sealed in tubes. On the 10th, five of the tubes were set aside, and the remaining thirty were placed in an oil-bath and gradually heated up to 100° F., and kept at that temperature for half an hour. Five of the tubes were then taken out, and the temperature raised successively to 200°, 300°, 400°, 500°, and 600° F., kept at each temperature half an hour—five tubes being taken out at the end of each half-hour, or at each of the above points of temperature.

On the following day, one of the tubes which had been heated at each determined temperature was opened, the cloth moistened with water, and a quarter of an hour afterwards examined under the microscope, giving the results specified on Table I.

On the 14th of August, one of the small tubes from each series was broken, and the heated cloth introduced into seven tubes, each containing 400 grains of pure distilled water free from life, and left for three days to ascertain if the life which had resisted 200° and 300° F. was still capable of reproduction, and if the germs, as well as the animalcule, had been destroyed by a temperature of 400°, 500°, and 600°.

A second series was made by introducing similar pieces of cloth, which had been also heated to the different temperatures, into tubes containing an albumen solution, made by mixing one part of white of egg with four of absolutely pure distilled water free from any trace of life, and these set aside for the same length of time to corroborate the above results.

The different fluids from both series were then microscopically examined on the 17th inst., and Tables II. and III. show the result.

From an examination of Table I., it will be seen that life was *not* destroyed in the fabric at a temperature of 300° F., whilst *it is* destroyed at 400°, and that these results coincide with those obtained when microscopic life were submitted to heat in the fluids in which they had generated, but differ from those observed in the experiments described in my last paper where a fluid full of microscopic life was placed on slips of glass dried carefully, either at natural temperatures or in an air-bath at 212° previously to being heated in the oil-bath at higher temperatures—and no doubt it will have been noticed that life disappeared after 300° in the former, whilst it was only destroyed after 400° in the latter; these results are no doubt due to the albuminous nature of the protoplasmic life existing under these circumstances. These facts are in accordance with results obtained by my learned master, M. Chevreul, forty years since,—namely, that it requires a much higher temperature to render albumen insoluble when once deprived of its water than when it is in its natural state,—and all chemists know that the coagulating-point of an albuminous solution bears a certain ratio to its point of concentration. The only explanation I can offer for the destruction of life at 300° in dried calico, is that the fabric (having been, as will be seen further on, softened at 300°) proves that it has undergone a decomposition, and, therefore, that part of its elements have united together to form water, which would become high-pressure steam at the temperature at which I operated, and, to use a common expression, cook the albumen.

It will also be remarked that the amount of life in the cloth heated to 300° is similar to that on the plates of glass—viz., that in both instances it is much more abundant than when such animalcules were heated in the fluids in which they had generated, which illustrates the fact that the greater the amount of fluid in which animal life exists, or the larger the proportion in which it exists in the animal itself, the lower is the temperature at which life is destroyed.

As it was interesting to know what changes the calico had undergone at the various temperatures above cited,

TABLE I.—Examination of the fabrics after having been heated as follows :—

Water used for Experiment.	Cloth. Not heated.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.	8.
No vibrios nor *bacteria*.	A considerable quantity of vibrios are present moving to and fro. No swimming vibrios are present.	About the same quantity of life is present here as in 2, and with about the same amount of vitality.	A little less amount of vibrios is present here than in 2 or 3, but a large quantity is still present, and they possess about the same vitality as 2 or 3.	Considerably less life here than in 4, but several distinct vibrios are present under each field moving to and fro.	No life.	No life.	No life.

TABLE II.—*Water Series.*—Examinations of the fluids in which some of the heated fabrics had been introduced. This series commenced on August 14, 1871; examined microscopically on August 17.

Water alone for comparison.	Cloth. Not heated.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.	8.
No vibrios nor *bacteria*.	The whole bottom part of each of the fields of the microscope is covered with long, ordinary, and small-sized *bacteria*. Three or four ordinary, long, and small vibrios are swimming about under each field.	Thirty to forty long *bacteria*, and three or four long swimming vibrios are present under each field.	Forty or fifty long, ordinary, and small *bacteria* are present under some of the fields, and very large shoals of these *bacteria* under others. One or two long vibrios are swimming about under each field.	The bottom parts of each field is covered with ordinary, long, and small *bacteria*. And a considerable number of long vibrios are present throughout the drop.	No *bacteria*, and no vibrios present.	No *bacteria*, and no vibrios present.	No *bacteria*, and no vibrios present.

TABLE III.—*Albumen Series.*—Examination of the albuminous solutions in which had been introduced heated fabrics. Commenced on August 14, 1871; examined on August 17.

Albumen solution alone for comparison.	Cloth. Not heated.	Heated to 100° F.	Heated to 200° F.	Heated to 300° F.	Heated to 400° F.	Heated to 500° F.	Heated to 600° F.
1.	2.	3.	4.	5.	6.	7.	8.
No vibrios present.	Twenty to thirty ordinary vibrios and microzyma, and a small number of long and very long vibrios are present, swimming about in all directions under each field.	Nine or ten long and very long swimming vibrios, and four or five long vibrios, merely moving to and fro under each field.	About the same amount and kind of life is present here as was observed in 3, or that heated to 100° F.	Four or five long and very long swimming vibrios and one or two small lots of vibrios joined together.	No vibrio present.	No vibrio present.	No vibrio present.

one of each of the small tubes which had been heated to the different temperatures was broken, and its contents carefully examined. The piece of fabric which had not been heated at all and those heated to 100° and 200° F. were quite sound; whilst that heated to 300° was of a slightly brown colour, much injured, and for practical purposes completely spoiled. At 400° F. the cloth was very much charred, almost black, and crumbled easily into powder when rubbed between the fingers; the tubes contained a large volume of gases, owing to the decomposition of the cloth. At 500° F. the cloth had been completely carbonised, and the tube contained also much gas. At 600° F. the cloth was completely decomposed into charcoal, and various hydrocarbon gases generated.

The above results clearly show that germ life placed under the above circumstances is not completely destroyed at 300° F., whilst it is at 400°. These facts not only confirm my previous results, but demonstrate, at the same time, that the temperature which will not destroy germ life is quite sufficient to materially injure cotton fabric. From these carefully conducted experiments, I am led to the conclusion that no beneficial results can be obtained by the employment of public stoves as a means of destroying germ life and contagion.

ON THE

ESTIMATION OF SULPHUR BY BARIUM.

By NICHOLAS GLENDINNING and ALFRED EDGER,
Newcastle-on-Tyne.

Our experience in the estimation of sulphur in pyrites by the gravimetric method has not led us to the same conclusion as that arrived at by Messrs. Teschemacher and Smith.

We have often had occasion to make duplicate determinations of sulphur in the same sample of pyrites, and the results have been such as to prove to our satisfaction that the method is capable of giving at least concordant results.

We are of opinion that Messrs. Teschemacher and Smith attribute too much of the differences between results obtained by this method to the solubility of sulphate of barytes in hydrochloric acid. The fact that sulphate of barytes is gradually deposited when the clear filtrate and washings are allowed to stand for some time, will admit of a different explanation than that offered by them, that "sulphate of barytes is noticeably soluble in hot and but moderately diluted hydrochloric acid." We attribute this to sulphate of iron, which is invariably carried down with the sulphate of barytes, and which appears on treatment with hydrochloric acid, after the precipitate has been freed from chloride of barium. That this is a correct interpretation may be proved by the following experiment. Oxidise about 50 grs. of pyrites, evaporate to dryness, add hydrochloric acid, and again evaporate to dryness; then take up with about 100 fluid grains of hydrochloric acid, add water and filter, and to the filtrate, at the boiling-point, add chloride of barium gradually and in excess; allow to stand for two or three hours, then filter and wash the precipitate of sulphate of barytes with hot water, until sulphuric acid fails to indicate barium in the washings; at this point treat the precipitate with hot, moderately dilute hydrochloric acid and filter; repeat this operation two or three times, then evaporate the acid washings to dryness, take up with a few drops of hydrochloric acid and water, filter to remove any trace of sulphate of barytes, and to the filtrate add chloride of barium, which will at once produce a precipitate of sulphate of barytes. In making this experiment care must be taken to use hydrochloric acid, which leaves no sulphuric acid on evaporation.

In the actual determination of sulphur, it is of great importance to obtain the precipitates as free as possible from sulphate of iron, and more especially when they are to be treated with hydrochloric acid after ignition, otherwise a loss is unavoidable.

It is our experience that the longer the precipitated liquor is allowed to stand, the freer the sulphate of barytes is found to be from sulphate of iron.

We have found in many instances on treating ignited sulphate of barytes with hydrochloric acid, that small quantities of sulphuric acid might be detected in the washings, but when precipitates have been subjected to an intense heat for a considerable length of time, such will probably not be the case.

We have since the publication of Messrs. Teschemacher and Smith's paper made experiments on a sample of pyrites, the results of which we beg to lay before our readers after first describing the *modus operandi*, which is as follows:—

Four portions of pyrites, 25 grs. each, were oxidised by red fuming nitric acid, evaporated to dryness in a water-bath, re-dissolved by a little hydrochloric acid, and again evaporated to dryness, again re-dissolved in hydrochloric acid, water added and filtered; the filtrates, measuring about ten ounces each were then heated to about 180° F., and the sulphuric acid precipitated by gradual addition of chloride of barium. It sometimes occurs on heating the filtrates before precipitation, that they assume a deep reddish colour: we consider this an unfavourable condition of the solution, and we add a little hydrochloric acid, which restores the light amber colour.

The precipitated liquors were allowed to stand in a warm place for about eight hours, and then filtered. We intended to have examined the strong filtrates for sulphate of barytes, but were prevented by want of time; but we can say from previous experience that only traces would have been found.

The sulphate of barytes precipitates were washed repeatedly by decantation with small quantities of hydrochloric acid and boiling water, until the addition of a little strong hydrochloric acid to the precipitate failed to give a colouration indicative of the presence of iron. They were then transferred to the filters, and thoroughly washed with boiling water. The whole of the washings, after the addition of a little chloride of barium, were evaporated to dryness, and the quantities of sulphate of barytes obtained, amounting generally to about 0·5 grs., added to the original precipitates, three of which after ignition and weighing, were treated with about 500 grs. strong hydrochloric acid, and allowed to stand for twelve hours in a warm place; the small quantities of sulphate of barytes dissolved by the acid were recovered and added to their respective precipitates.

The following are the results:—

	Before treatment with HCl.			After treatment with HCl.		
	Grs. $BaOSO_3$.		Grs. S.	Grs. $BaOSO_3$.		Grs. S.
No. 1	83·12	=	11·415	83·08	=	11·411
,, 2	83·18	=	11·423	83·12	=	11·415
,, 3	83·30	=	11·440	83·23	=	11·430
,, 4	83·23	=	11·430			

It will be seen from the above figures that the greatest loss on treating the precipitates with HCl amounts to only 0·07 grs. $BaOSO_3$, probably attributable to the precipitate having retained a small quantity of sulphate of iron. We think the above experiments are sufficient to prove that constant results and precipitates of reliable purity are obtainable by the gravimetric method.

We have not had an opportunity of experimenting on protosulphate of iron, but we are of opinion that the estimation of sulphuric acid in the oxidised substance presents greater difficulty than is offered in the case of pyrites, inasmuch that the proportion of oxide of iron to the sulphuric acid is much greater in the case of protosulphate of iron than in that of oxidised pyrites.

We have shown that sulphate of iron is carried down with sulphate of barytes, and are of opinion that this

property, which offers the greatest drawback to the gravimetric method, will also affect the results obtained by the volumetric method recommended by Messrs. Teschemacher and Smith.

NOTES FROM THE INTERNATIONAL EXHIBITION OF 1871.

THE chemical contributions to the exhibition of this year are very few, but of the highest technical importance. And here arises a difficulty as to the order in which they shall be considered, the dispersion in various parts of the building precluding the following of the numbers of the catalogue; while it would be impossible to make an arrangement according to merit. It is perhaps the best plan to walk through the building, and observe which chemical product exhibited most attracts the attention of the visitors. Entering the exhibition at the south-east gate, where most of the visitors arrive, and, being bent upon a scientific exploration, allowing but a few minutes to the seductive curiosities of the Indian Court, we pass by the collection of British and foreign paintings, the valuable Meyrick collection of armour, down and up the steps where the Whitworth ordnance stood when these galleries formed part of the South Kensington Museum, to the ground floor of the West Gallery, chiefly devoted to scientific invention. Bearing our object in mind, the case most eulogised by the visitors in the exclamation "Those beautiful colours," is that (7609) belonging jointly to Messrs. E. C. Nicholson and D. S. Price, in which are exhibited the coal-tar products, rosaniline-base, acetate of rosaniline, and chloride of rosaniline. Fourteen years ago, aniline-violet, or "mauve," the first colour from coal-tar, was prepared on a practical scale by Mr. W. H. Perkin; next, in 1859, followed aniline-red or magenta, and then a series of brilliant colours. The present exhibit is illustrative of the system of manufacturing the magenta dyes. In 1859, when Messrs. Verguin and Renard Frères first manufactured aniline-red by the action of tetrachloride of tin upon aniline, there was little idea of the extension of the industry that would ensue from the discovery of Messrs. Nicholson and Price that this colour is the salt of a colourless base, rosaniline. (7609) includes two blue dyes derived from aniline, exhibited by Mr. E. C. Nicholson on his own account; they were first prepared in 1862 and 1863, and both are of considerable technical importance. The first is known as "soluble blue," and is produced by the action of strong sulphuric acid upon Girard's blue, also a product of aniline. For wool it has little affinity, even with a mordant, consequently its use is limited to the dyeing of silk and feathers. It is the salt of a new acid, the constitution of which is as yet unknown; but it will probably prove to be a conjugate sulpho-acid, bearing a similar relation to Girard's dye as sulphindigotic acid does to indigo. The salts with the alkaline bases are very soluble in water, but with difficulty in alcohol; the aqueous solution, if neutral, has a light blue tint, nearly disappearing on the addition of an alkali. The blue colour is developed, but not precipitated, by acids. The export of this dye in the dry state to China and the East is very large, on account of the ease with which it may be applied, and the excellence of the result. Mr. Nicholson's second dye, known as "Nicholson's blue," or "fast blue," is intended for woollen fabrics, to which it is peculiarly suited by its property of dyeing in an alkaline solution, and to its entire insolubility when precipitated by a mineral acid. The process of dyeing with this colour is also due to Mr. Nicholson, and is extremely simple. The goods are first boiled in an alkaline bath, to which the quantity of dye required to produce the desired tint has been added; the whole of the die in the bath is soon absorbed; the goods are then washed and passed into a bath of boiling water, containing a small quantity of a mineral acid, in which the blue colour is developed. As the dye exists in *solution* in the first bath instead of in *suspension*, the fibres of the material are completely penetrated by it; and when the second bath is employed, precipitation of the blue colour instantly takes place among the fibres; thus a fast colour is obtained, slightly affected, however, by washing with soap.

Messrs. Perkin and Sons have a most interesting case (7516) illustrating the conversion of anthracene into alizarine. The series includes the two extremes, crude anthracene and the pure colouring matter; and also specimens of fabrics dyed and printed with artificial alizarine. Messrs. Southwall and Briggs (7550) exhibit anthracene purified by pressure and sublimation according to Mr. Wavey's process, as well as the several stages of conversion into alizarine.

Allied to aniline, as a constituent of coal-tar, is phenol, or carbolic acid, first manufactured in this country by Dr. F. Crace Calvert, who exhibits (7433) a magnificent specimen prepared for medical purposes, and which fuses at 42·2° C. (108° F.) There is also a complete collection of the various forms of carbolic acid applied to curative and sanitary purposes. Messrs. Calvert state that the monthly sale by them of carbolic acid for medical purposes amounts to about seven thousand 8-oz. bottles, while there is a correspondingly large consumption of the preparations which contain from 10 to 20 per cent of the substance, especially the "carbolic acid soaps," and the convenient and efficient disinfectant known as "carbolic acid powder." A medal was awarded to this firm in 1867 for their monohydrate of phenol, the purity of which greatly enhanced the beauty of the colours obtained from carbolic acid, such as picric acid, rosalic acid, aurine, &c.

Actuated by a desire to see what such a destructive agent is really like, many of the visitors throng to the stand (7520) of specimens illustrating the manufacture and application of compressed gun-cotton exhibited by the Patent Safety Gun-Cotton Factory, formerly Messrs. Prentice and Co., of Stowmarket, Suffolk. This variety of gun-cotton is manufactured on Professor Abel's system; and as this eminent chemist is Official Reporter to the *Chemical Section*, it may not be uninteresting to quote the particulars of the system from the Report:—

"The starting point in the production of this gun-cotton is not cotton-wool, as was the case in Schönbein's original process, nor cotton of long staple spun into loose strands or threads, as employed in Von Lenk's system of manufacture. Any form of cotton refuse (*e.g.*, the so-called "machinery waste") may be employed, provided it be quite clean, and in a loose condition, so as to admit of its rapid impregnation by the acids with which it is treated. The process of converting the cotton into the most explosive form of gun-cotton or trinitro-cellulose, does not differ in any fundamental point from that first applied in 1846. The cotton, after being very carefully dried, is immersed, in small quantities at a time, in a perfectly cold mixture of one part of nitric (sp. gr. 1·5) and three parts of sulphuric acid (sp. gr. 1·85) and is afterwards allowed to remain for twenty-four hours in contact with about ten times its weight of the mixed acids, to ensure as complete a conversion as possible into gun-cotton. The vessels containing the cotton and acids are kept closed, and as cool as practicable; and, at the expiration of the proper period, their contents are transferred to a centrifugal extracting apparatus, by which the gun-cotton is separated to a very great extent from the excess of acid. It is then suddenly plunged, by means of simple mechanical arrangements, in very small quantities at a time, into a large volume of water. The object aimed at is to dilute the acid which remains in the gun-cotton with water so quickly as to avoid the development of heat, and the consequent establishment thereby of a second violently oxidising action of the nitric acid upon the gun-cotton—an action which, though only of the brie

duration, would affect prejudicially the quality and perhaps also the stability of the product. The adoption of this precautionary measure, and the long-continued digestion of the gun-cotton with considerable excess of acids, constitute the prominent improvements which Baron Von Lenk effected in Schönbein's process for *producing* gun-cotton. After this preliminary washing, the gun-cotton is drained of water by means of the centrifugal extractor; it is then rinsed twice in a large volume of water, and passed through the centrifugal machine after each rinsing. It is now transferred to a rag engine of the kind ordinarily used in producing pulp for paper making. By this operation the gun-cotton is reduced to the state of fine division necessary for its subsequent conversion into homogeneous compressed masses; it is subjected, at the same time, to a most searching purification, which is continued in the next operation, the pulp being transferred to "poaching" engines, in which it is beaten about in a very large volume of slightly warm water, which is renewed from time to time. This final washing operation is carried on continuously until the gun-cotton has passed satisfactorily through a very searching test for purity, and generally lasts about 48 hours. This method of washing constitutes one of the great advantages of the present system of manufacture. The chief obstacle to the complete purification of the gun-cotton consisted formerly in the obstinate retention of impurities within the hollow fibres. With a view to their removal, Von Lenk prescribed continuous washing during many weeks in running water, and subsequent boiling with very dilute alkali. But by the application of the pulping and poaching processes, the capillary action of the fibre is greatly reduced, and the washing operation is rendered so searching that a decidedly more complete and uniform purification of the material is accomplished in three days, at the outside, than was previously attained by processes which extend over six or eight weeks. At the conclusion of the washing process, the gun-cotton pulp is converted, by a preliminary moulding process, and subsequently by hydraulic pressure, into compact masses of cylindrical and other forms of about the same density as water, and of dimensions suited to the particular applications required of them. During the whole of these manufacturiug operations, the gun-cotton is wet, and therefore absolutely uninflammable. After compression, the finished material is dried upon hot plates, which are freely open to the air at the sides, and is then packed in light wooden boxes for storage or transport. Compressed gun-cotton, prepared from the pulp as above described, possesses decided advantages over the forms of that explosive agent which have been previously manufactured, as regards compactness, uniformity, stability, and safety. It requires very strong confinement for the development of its explosive force by the ordinary modes of applying flame or heat; if inflamed in open air, or when confined in ordinary packing cases, it does not flash into a flame with explosive violence, like gun-cotton wool or yarn, but simply burns. It may, however, be made to explode with great violence in open air, and to exert a most powerfully destructive action, if fired through the agency of a detonation, such as is produced by the explosion of a small quantity of fulminate of mercury strongly confined. In this respect it resembles nitro-glycerine, and this property obviously renders it applicable, simple and expeditiously, to many important military, mining, and engineering operations. Unless gun-cotton be in the highly compressed form in which it is now produced, it is not susceptible of explosion *unless very strongly confined*. From the Patent Safety Co.'s works eight to ten tons of gun-cotton were sent out weekly. Government works are also in the course of completion for the extensive manufacture of compressed gun-cotton, which has been introduced into the Service for several military purposes, and as the explosive agent to be used in submarine mines.

Near at hand is an exhibit of Messrs. Rose and Gibson (7522) of specimens of oil and paper prepared from cotton seed. The crop of American cotton gathered during the last season amounted to some 800,000 tons, and the weight of the seed to 1,958,620 tons, a quantity of cotton fibre, however, amounting to one-third the weight of the seed not being separated in the ginning. This has hitherto been waste, but is now utilised by Messrs Rose and Gibson by passing the seed-husk with its fibrous coating between peculiarly constructed rollers to separate the kernel. A treatment with alkali is next effected, by which the fibre is loosened from the shell; it is afterwards washed and bleached. It is estimated that the seed of last year's cotton crop is capable of yielding 274,206 tons of fibre worth £30 per ton, besides 311,420 tons of crude oil worth £27 per ton, and 726,648 tons of oil-cake, worth £9 per ton as food for cattle. A case containing specimens of paper-pulp produced from wood (7551) is exhibited by Messrs. Smith and Granville; but no information is afforded as to the mode of treatment. The fibre is long and of fine colour.

Mr Walter Weldon (7561) exhibits specimens illustrative of his process for the manufacture of chlorine. The *rationale* having been before the readers of this paper in previous numbers (see CHEMICAL NEWS, vol. xxii., No. 565, p. 145), it is unnecessary to enter upon details here. By the Weldon process of re-oxidising manganese, nearly 500 tons per week are being made. The cost of recovering the quantity of manganese required for the liberation of a given quantity of chlorine is less than one-fourth the average cost for the last five years of the native manganese required to do the same work. It will have been seen that the chemical exhibitors, although not numerous, present the result of much thought and labour; and all those in the least interested in technical production should at once visit the Exhibition who have not already done so. It closes with this month.

(To be continued).

CORRESPONDENCE.

NEW FORMS OF GALVANIC BATTERIES.

To the Editor of the Chemical News.

SIR,—I send you a brief account of the results of my experiments on galvanic batteries. I tried some thousands of experiments, and kept batteries at work, watching them night and day for several months.

I soon found that the great point to secure constancy was a good negative. The positive is of minor importance, as the oxidation or other similar chemical change which takes place there produces a change of specific gravity in the liquid, securing a circulation and consequently a continuation of the action. This is much assisted by the action of heat, which itself, if applied at the bottom of the vessel, produces a circulation, and at the same time increases the conductibility of the fluid.

But the substances conveyed to the negative ordinarily cling there, and both by their chemical reaction and by forming a film on the surface soon immensely reduce the potential. This difficulty has been overcome in several ways, which I will proceed to discuss.

(1.) By a solution of copper, which absorbs hydrogen and produces metallic copper. Hitherto, this, on the whole, has been found the most convenient method for ordinary purposes, as in the Daniell battery. But to this there are many objections:—

1. Copper is not a very powerful negative, and to get a good potential requires an expensive positive, such as zinc, magnesium, &c., in order to secure much power. Copper and iron, for instance, are so near in their potential as not to give more than half the potential of copper and zinc, and consequently, when the expense of the negative is taken into consideration, the use of iron effects but little economy.

2. There is so much water of crystallisation in sulphate of copper, that it requires very nearly four pounds to sulphoxidise one pound of zinc.

3. Sulphate of copper is not only rather insoluble, but is a nasty creeping salt, which is sure to find its way wherever you want to keep it out, and by getting to the zinc sets up a local action, wasteful and injurious. Every one who has used a Daniell battery for long knows how troublesome it is to keep in order.

The last difficulty may be obviated by using a neutral salt and silicate of soda with the zinc. The silicate precipitates the salts both of copper and zinc as silicates, and adds much to the steadiness and efficiency of the battery. With a mixture of nitrate and silicate of soda, magnesium may be used as a very powerful positive, and without any local action, which usually destroys it almost immediately. It is an expensive but most convenient and powerful positive.

(2.) By nitric acid with the negative to oxidise the hydrogen. This is very good for a short time, but the acid losing part of its oxygen soon becomes gaseous and fumes, both weakening the potential and proving very injurious to the health and comfort of any one subject to its influence.

(3.) Chromic acid. This, as chromic acid, though an excellent negative, is very expensive, being sold ordinarily at one shilling an ounce. Chromate of potassium, which is commonly used with sulphuric acid, is both expensive (being now I believe £90 per ton, wholesale) and very insoluble. Bichromate of soda is both much better and much cheaper (about £45 a ton now), but is difficult to procure, being sold only in lots of four tons. The potential of chromic acid is great—considerably greater than nitric acid—but soon becomes weaker, as it passes through the stages of chromoso-chromic, chromous oxide, &c.; mixed with nitric acid, it helps to stop the fumes, as chromous acid absorbs nitric oxide gas.

(4.) As far as I know, I have been the first to use the permanganates with acid; they are very powerful—more so than even chromic acid—but require adding gradually in order to supply oxygen, otherwise the oxygen flies off and the effect is lost. The action is so powerful that I have seen the wet coke electrode actually burst out into a flame on the first application of a permanganate with sulphuric acid. The permanganate of soda may be had at about £40 a ton, and therefore is not a very expensive source of oxygen.

(5.) As far as I know, too, I have been the first to use the chlorates, or chloride of lime (so called) with an acid; they are powerful negatives, but not so powerful as chromic or permanganic acid, and the evolution of chlorine in a gaseous form is objectionable.

(6.) Sulphate of mercury is expensive and very slowly soluble. Marie-Davy introduced it in France, but I hear it is now abandoned for sulphate of copper.

(7.) Peroxide of manganese. In some cases this is useful where a battery is very little used; but without acid it parts with its oxygen very slowly, and the Leclanché battery in which it is used very soon exhausts itself when put to do any hard work. At the Post Office after an hour's work, it has to be removed and a fresh one substituted till it has recovered itself.

(8.) My experiments at last led me to the conclusion that by far the best and cheapest negative is the air itself, which of course is practically used always in oxidising coal for producing power. For this purpose I pack the negative, carbon or platinum, in a high porous cell with cinders or similar material broken so as to be freely pervious to the atmosphere, and forming a damp porous bed, on the surface and pores and cavities of which the deoxidised materials may recover their oxygen. Thus the nitric oxide fumes are oxidised and flow back as nitroso-nitric acid; hydrogen is oxidised into water, especially if a little platinum black be sifted on the surface of the cinders and made to cling to it by dipping the cinders in a little soap and water. A battery thus, if not overworked, becomes perfectly constant. If very hard work be required, the dimensions of the porous jar must be enlarged, and holes pierced above the level of the liquid to secure a good draught of air through the coke. The porous cell should of course only partially be filled with the liquid. I find the best plan is to put the zinc or iron in a neutral solution, which prevents the necessity of amalgamation, and to place in the porous cell with the carbon sulphuric and nitric acid in proportions proper for sulphoxidising the zinc. If sulphur be put in the cell with the zinc or iron, the oxidising of the sulphur will furnish the sulphuric acid, and save the necessity of sulphuric acid in the negative cell. With this negative iron may be advantageously used as a positive, as the potential of iron with a powerful negative is about ⅔ of zinc, thus effecting a very considerable saving.

A very convenient battery is formed by using a solution of sulphate or muriate of ammonia for both parts of the cell. The acid unites with the zinc, and the ammonia and the hydrogen are oxidised on the coke, or partly oxidised, so as to form a solution of nitrate of ammonia, which itself acts over again.

Having obtained this excellent negative, I amused myself with trying almost every conceivable oxidisable substance as a positive. Of course a metal is quite unnecessary, any oxidisable liquid with carbon to collect the electricity being as effectual as a metal. Sulphur, a mixture of sulphur and carbonaceous matter (as in gunpowder), sugar, sawdust (especially with peroxide of manganese and sulphuric acid to decompose it), brandy and water, gruel, tea, broth, all gave good currents; the positive part of the cell acting the part of the stomach in the human body, and the porous cell with its cinders playing the part of the lungs. Again, all solutions of salts only partially oxidised, such as the hyposulphites, the cyanides, the sulphates, ferrous salts, gave exceedingly good currents, many of them fully as strong as a Daniell battery. The most powerful are of course the soluble sulphides, which in their first stages of oxidation are 60 or 70 per cent stronger than a Daniell, getting weaker as they go through the process of becoming sulphites and thionates. But as a hyposulphite is more valuable than a sulphide, the product after the first stage of oxidation is more valuable than the substance used, so that the electricity is got for less than nothing. Waste sulphide of calcium may thus become an important source of electrical and mechanical power. Heat, as it greatly increases the affinity of sulphur for oxygen, very much assists the action of these batteries. Again, ferrous sulphate gives an excellent current, and if we keep it in the condition of a ferrous salt by placing in it a sulphide of iron, forms a very cheap, indeed costless, source of electricity, because sulphate of iron is more valuable than a sulphide.

I will only add that I found that any common battery as the Wollaston, the Smee, and the Walker, if placed over a source of heat, so as to evolve steam from the negative, is made very powerful, and perfectly constant; the steam sweeping away the hydrogen from its surface. The common Walker battery is thus made equal to a Grove, and a Wollaston to a Daniell.

Now this production of cheap electricity opens a wide field for the substitution of magnetism for steam power. Even if Joule's theory were true, magnetic power could be produced as cheap as steam power. But I repeat, what I have written and explained privately to Dr. Joule, that his original experiments in 1843, when carefully and minutely examined, overthrow his own theory. Men like Sir W. Thomson and Tait doubtless do not like to be told that their elaborate science, built up mathematically with so much care and trouble, is based on a quicksand, and is inconsistent with facts. You know yourself how much odium and what violent attacks you have incurred by inserting my articles, which, though no doubt they contain mistakes, are in the main true. The British

Association absolutely refused to hear me, or even to admit a description of my batteries, lest, I presume, heresy should lurk even in them; but I noticed notwithstanding a considerable change in the tone in which both Sir W. Thomson and Tait spoke on the subject; though the latter took for granted the absurd supposition that $-272°$ is the absolute zero of temperature, which idea I find good judges consider I conclusively disproved in an article some months since in the CHEMICAL NEWS; and where is the report of the committee appointed to determine the mechanical equivalent of heat? £50 was paid to them in 1870 for their expenses. What have they found to be the mechanical equivalent? They maintain a judicious silence themselves, though they are determined, as far as in them lies, to silence me too.

I urged a friend of mine, Mr. Slater, the optician, of 136, Euston Road, who has the apparatus required and well-constructed magnets, to try how much power he could get by electricity. He writes to me to say that, by accurate measurements and weighings, he has got 300 foot-pounds out of a grain of iron, and he is persuaded that by improved mechanism he could get at least six times as much. Now, even 300 foot-pounds to a grain of iron is only nine pounds of iron per day of ten hours for a horse-power, a cost which may vie with steam in economy. And taking sulphide of calcium or of iron instead of iron, we can reduce the cost per horse-power to a mere trifle. The only question is the cost and convenience of the machinery. Even if the American statements are an exaggeration, this question must soon be the question of the day for all mechanists and engineers.—I am, &c.,

H. HIGHTON.

2, The Cedars, Putney,
Sept. 18, 1871.

PS.—Since writing my letter, my ingenious friend Mr. Slater, by a larger battery, has obtained 1,371,088 foot-pounds of work from 7 ounces of iron, or 388 per grain; this with two electro-magnets rotating before a fixed electro-magnet.—H. H.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, August 14, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

New Volatile and Sweet Principle found in the Caoutchouc of Bornéo.—A. Girard.—After briefly referring to his researches (in 1866) on dambonite, $C_6H_8O_6$, a sweet saccharine substance found in the caoutchouc of Gabon, and on dambose, $C_6H_6O_6$, a derivative from dambonite by the action thereupon of hydriodic acid, the author communicates the results of his researches on the caoutchoucs obtained from climbing plants belonging to the genus *Urceola*, and grown in Madagascar as well as in Bornéo. These kinds of caoutchouc contain, enclosed among the real caoutchouc substance, a body, very soluble in water, which the author has named *Bornesite*, which in pure state is a crystalline solid body difficultly soluble in strong alcohol, which fuses at 175° without decomposition, and sublimes at 205° with but partial decomposition. Bornesite is not capable of undergoing fermentation, and does not reduce the cupro-potassic tartrate solution unless it has been first acted upon by very dilute sulphuric acid. Treated with nitro-sulphuric acid, bornesite is converted into a nitrated crystalline body, insoluble in water, soluble in alcohol, fusing at about 35°, and detonating by a blow. The formula of bornesite is $C_{14}H_{16}O_{12}$; treated with an excess of hydriodic acid, at 120° in a sealed tube, it yields, as does dambonite, ether methyl-iodhydric and dambose. While neither dambonite nor dambose act at all upon polarised light, bornesite was found to be dextogyrate.

Influence Exercised by the Difference of Size of the Polar Electrodes of a Galvanic Battery.—T. Du Moncel.—The contents of this paper and of the following are not suited for useful abstraction.

Molecular Properties of Saline Solutions considered according to the Densities thereof.—C. A. Valson.

Apparent Volatilisation of Silicium and Boron.—L. Troost and P. Hautefeuille.—The authors describe in this lengthy memoir a series of experiments made with pure silicium and boron, each by itself, placed in porcelain tubes, kept at a very high temperature (in a slow current of dry and pure hydrogen gas), and the reaction which ensues by the admission, into the tube, of fluoride of silicium, chloride of silicium, and fluoride of boron. Silicium is under these conditions apparently volatilised, forming a brown-coloured smoke, which, in a cooler part of the tube, is condensed sometimes as amorphous silicium, sometimes deposited in crystalline state. The same obtains with boron, but this apparent volatilisation is due to a simple mechanical effect, conjointly with the existence of compounds of silicium with chlorine and fluorine which are only formed at a very high temperature and dissociated at red heat.

Thermo-Chemical Researches on the Cyanogen Series.—Dr. Berthelot.—This essay contains the following sections:—Cyanhydric acid; potassium cyanide; cyanhydrate of ammonia; cyanide of mercury; cyanate of potassa; chloride of cyanogen; iodide of cyanogen; bromide of cyanogen.

Production of Ammonia by the Alcoholic Fermentation.—M. Dubrunfaut.

Presence of Milk Sugar in a Juice of Vegetable Origin.—Dr. G. Bouchardat.—The author relates at length a series of experiments made with a specimen of sugar obtained (1837) from the juice of the *Achras sapota*, at Martinique, the specimen being preserved among the objects known as belonging to the *Matière Médicale de Merat*. By treating a portion of the sample of the sugar alluded to with boiling alcohol at 90 per cent, there was left undissolved a substance which, on further investigation, was found to possess all the physical and chemical properties of milk sugar. A careful quantitative analysis of the sample established the fact that it contains 55 per cent of cane sugar and 45 per cent of milk sugar, which latter was also found to exist in the ripe fruit of the same tree recently brought from Egypt and analysed by the author.

This number also contains several important papers relating to meteorology.

August 21, 1871.

This number contains the following papers and memoirs relating to chemistry and collateral sciences:—

Quantitative Estimation of Nitrous and Nitric Acids in Rain-water.—M. Chabrier.—This essay contains, in tabulated form, the results of a series of experiments made chiefly at Saint-Chamas (Bouches du Rhône). It appears that, contrary to what is generally supposed to be the case, nitrous acid is far more generally present in rain-water than nitric acid, while nitrite of ammonia has also been found by the author; the quantity of nitrous acid in the litre of rain-water amounts to from 0·7 to 0·8 milligramme, the quantity of ammonia to from 0·30 to 0·35 milligramme, while of nitric acid only traces are found. Curiously, the quantity of rain which falls in the part of France above alluded to is the same as the quantity which falls in Paris, but in the former instance there are only fifty rainy days, to at least three times as many in the latter.

Petroleum and Paraffin Oils.—M. d'Abbadie de Barrau.—A letter addressed by the gentleman just named to the Academy, with the view of receiving the opinion of that scientific body on a process of fractional distillation executable on the large scale, and so contrived as to render the oils used for burning in lamps uninflammable without wicks at a temperature above 65° (156° to 158° F.), while the heavy oils are rendered suitable to be burnt in *moderateur* lamps without producing smoke and emitting an unpleasant smell.

Experiments on the Conversion of Mechanical Force into Heat. P. Volpicelli.

New Contribution to the History of Carbon.—Dr. Berthelot.—In the first part of this very lengthy essay the author treats on the properties of the carbon met with in the Cranbourne (near Melbourne, Australia) meteorite; this carbon must be considered as having been first in state of solution in molten iron, and to have separated therefrom on cooling. Next, the carbon obtained from oxide of carbon, by the decomposition of that gas by iron at a relatively low temperature, is considered. From the reactions of these substances, the author comes to the conclusion that native graphite, about the origin of which very little is known, is certainly not, at least as far as experiments can throw light on this point, derived from either anthracite or from decomposed masses of meteoric iron which contained carbon.

Reagent for Alcohol.—Dr. Berthelot.—When benzoic chloride, $C_{14}H_5ClO_2$, is put into contact with water it is only very slowly decomposed, but if the water contains any alcohol (even as little as 1 in 1000 parts of water) benzoic ether is at once formed: this ether is set free by a single drop of aqueous solution of caustic potassa, the odour of the ether being very peculiar and prominent.

Note on a Subchloride of Silicium.—C. Friedel.—After referring to formed researches on the silicium compounds, and to the researches of Troost and Hautefeuille, the author states that when hexiodide of silicium, Si_2I_6, is heated along with bichloride of mercury, there is formed, along with tetrachloride of silicium, another less volatile silicium chloride, Si_2Cl_6, and an oxychloride of silicium, Si_2OCl_6. By

passing chloride of silicium vapours over solid silicium, placed in a porcelain tube, heated to a very high temperature, beside acicular silicium crystals, very hard solid agglomerated silicium was obtained in sufficient quantity to serve instead of carbon (graphite) as conductors for electricity and the production of electric light.

Petroleum Oils of the Bas Rhin.—M. Le Bel.—The contents of this paper contain an account of the various hydrocarbons obtainable from bituminous shale, which is submitted to dry distillation for the purpose of manufacturing what is, in this country, generally termed paraffin oil. The author has obtained hydride of amyl, hydride of hexyl, and compounds of these bodies from the oil alluded to after having been treated with sulphuric acid.

Some Metallic Trichloracetates.—A. Clermont.—This paper treats on:—Trichloracetate of baryta, $C_4Cl_3O_3,BaO+6HO$, a crystalline, but very deliquescent, salt; trichloracetate of strontia—

$$C_4Cl_3O_3,SrO+6HO,$$

also a crystalline salt, less deliquescent than the preceding, but readily soluble in water; trichloracetate of lime; and trichloracetate of soda.

This number also contains several papers on astronomy, meteorology, and geology.

Polytechnisches Journal von Dingler, first number for August, 1871.

The following papers and essays relating to chemistry and collateral sciences are contained in this number:—

Studies on Blast-Furnaces for Iron-Works.—C. Schinz.—The first portion of a lengthy monograph on this subject containing the following sections:—Introduction; statics of temperature in blast-furnaces; utility and purpose of the statics of temperature.

Method of Removing and Utilising Phosphoric Acid from Iron Ores.—J. Jacobi.—The author proposes to convert the phosphoric acid present in many ores into a soluble state, by treating the same with sulphurous acid and water, to be forced into the previously ground up ores by means of properly constructed machinery. The ore is next washed with water, and the phosphoric acid solution applied for agricultural manure.

Description of an Apparatus for Determining the Melting-Point of Organic Substances.—J. Löwe.—Illustrated with engravings. It appears that, for accuracy of results and nicety of means of observation, this contrivance deserves special notice. The description requires the aid of engravings.

Extraction of Animal Fats to be used either as Food or for Cosmetic Purposes.—Dr. H. Vohl.—The fresh fat is first as much as possible freed from membranes and flesh, next cut up either into small discs or cubes, and then thoroughly washed with cold water (which should contain the least possible quantity of lime, therefore fresh river-, or, better, good rain-water, should be used) until all blood is entirely removed. The fat is next put into a cylindrical stoneware vessel, 1·25 metres high and 0·5 metre inside diameter, this vessel being placed in a water-bath and provided with a tap at the bottom, so placed that the vessel may be emptied without removing it from the water-bath. The vessel having been filled for three-fourths of its capacity with fat, there is placed on the top of it a stoneware perforated disc, and next poured over it (the fat) very dilute pure hydrochloric acid—10 per cent of the weight of the fat of an acid made up of 3 lbs. of chemically pure HCl at 1·12 sp. gr. to 100 lbs. of water (sulphuric acid is not to be substituted, because its solvent power for membranes is very slight). This having been done, the stoneware vessel is closed with a well-fitting cover, and the water-bath heated. From the fat, while melting, the perforated cover carries, by slowly sinking downwards, all the impurities, as far as they are not dissolved by the acid, which at the end of the operation is run off by aid of the tap. The fat is then, while yet molten, washed several times with warm water, to which, for the last washing, some carbonate of magnesia is added. The acid liquid yields, along with phosphorite or other native phosphate of lime, an excellent manure. The fat is next treated with Canada oil (a refined petroleum spirit), and the solution separated by decantation from any yet present nitrogenous organic matter (membranes, &c.). The solution of the fat is freed by distillation (in a water-bath) from the Canada oil, and the result is the production of a very superior fat, which, being absolutely free from water and other organic, especially nitrogenous, matter, is not liable to become rancid, and may be preserved for many years. Although the process here briefly described may appear complicated, it yields not only a better, but also far larger quantity of product.

Description of a Diffusion Apparatus for the Purpose of Exhausting the Active Principles from Vegetable Matter, and especially for Extracting, by means of Cold Water, Sugar from Beet-Root Pulp.—J. Robert.—With engravings.

Preparation of Fruit Juices.—U. Gräger.—A lengthy paper treating on the preparation of syrups from various kinds of fruit.

Prize Essay for the Estimation of the Value of Raw Beet-Root Sugar.—The directors of the Association for the beet-root sugar industry in the German Custom's Union (*Zollverein*) considering that the co-efficient 5, adopted by the French trade as measure for the melassimetric value of the salts contained in raw beet-root sugar, is not founded on scientific basis, have resolved to grant a sum of £150 for the best essay to the following query:—Since the quantity of crystallised white sugar contained in various samples of raw beet-root sugar does not stand in direct relation to the polarisation, what research (analysis) and calculations are to be made to estimate theoretically beforehand the yield (*rendement*) of white crystalline sugar contained in a sample of a raw beet-root sugar? If it happen that a complete and, in all respects, satisfactory answer to this question be not sent in, the nearest approaching solution of the problem will be paid for in a proportionate manner. The essays, to be written in German, to be sent, postage or carriage paid, on or before the 31st of January next, to Dr. Riedel, Privy Councillor, &c., 76, Klosterstrasse, Berlin. The decision and award of the directors will be made at their general meeting, May, 1872.

Annalen der Chemie und Pharmacie, August, 1871.

This number contains the following original papers and essays:—

Researches on the Constitution of Piperine and of the Products of its Dissociation—viz., Piperinic Acid and Piperidine.—R. Fittig and T. Remsen.—The second instalment of the lengthy monograph on this subject, containing the following sections:—Action of nascent hydrogen upon piperonal; hydro-piperoine, $C_{16}H_{14}O_6$; action of chloracetyl and of nitric acid upon hydro-piperoine; isohydro-piperoine; piperonyl-alcohol, $C_8H_8O_3$; action of nascent hydrogen upon piperonylic acid; action of hydrate of baryta, dilute hydrochloric acid, and water upon piperonylic acid; action of chloride of phosphorus upon piperonal; action of hot water upon dichlor-piperonal; action of chloride of phosphorus upon piperonylic acid; constitutional formulæ of the bodies treated of.

Volumetrical Estimation of the Typical Hydrogen in the Ammonia Bases, and on the Reactions Exhibited by Free Phenol-Hydroxyles.—H. Schiff.—The first portion of this paper is not suited for abstraction. From the second portion we quote the following:—The non-nitrogenous aromatic substances which are coloured by chloride of iron contain free phenyl-hydroxyles: this reaction ceases when, for the hydrogen of the hydroxyle, are substituted other groups. Nitro-derivatives either do not exhibit this reaction at all, or only in a very limited manner; the intensity of this coloured reaction appears to depend upon the number of the free hydroxyles present in the substances.

Researches on Glycerine and Allyl Compounds and their Behaviour towards each other.—H. Hübner and K. Müller.—This memoir, treating on the position of the constituent atoms of allyl-alcohol and derivatives obtained therefrom, contains the following sections:—Dichlorhydrine; decomposition of dichlorhydrine by sodium; conversion of dichlorhydrine into an isomeric dichlorhydrine; decomposition of epichlorhydrine by sodium.

Potassium Amalgam—Sodium Amalgam.—K. Kraut and O. Popp.—The authors describe a series of experiments made with solutions of carbonate of potassa of different strength, into which sodium amalgam was placed and left for longer or shorter time, the result being the formation of a crystalline potassium amalgam, mixed, however, with a very small quantity of sodium, which the authors consider to have been left in combination with the mercury. The percentage composition of several of the amalgams thus obtained is quoted; as instances, we mention the following:—Hg, 98·370; K, 1·560; Na, 0·036. Hg, 98·420; K, 1·31; Na, 0·119. Hg, 98·044; K, 0·934; Na, 0·641. Potassium amalgam—formula, K_2Hg_{64}; in percentages—Hg, 98·41; K, 1·59. Sodium amalgam, Na_2Hg_{12}, with 1·88 per cent sodium.

Phenylic Ether and Diphenylen-Oxide.—W. Hoffmeister.—This lengthy and very exhaustive monograph contains the following chapters:—Preparation of phenyl-ether by means of sulphate of diazobenzol and phenol; preparation of phenyl-ether from benzoate of copper; properties of phenyl-ether, and its behaviour with pentachloride of phosphorus, zinc-dust, chromic, sulphuric, and hydriodic acids; phenyl-oxide-bisulpho acid; binitro-phenyl-ether; biamido-phenyl-ether; bibrom-phenyl-ether; diphenyl-oxide; diphenyl-oxide-bisulpho acid; binitro-diphenylen-oxide; bibrom-diphenylen-oxide.

Disulphobenzoic and a New Dioxybenzoic Acid.—L. Barth and K. Senhofer.—This essay contains a complete description of the mode of preparation and the salts of the two acids alluded to. The disulphobenzoic barium compound has the formula—

$$C_7H_4S_2BaO_8+2H_2O=C_6H_3\left\{\begin{matrix}COOH\\SO_3\\Ba\\SO_3\end{matrix}\right\}+2H_2O.$$

The formula of the new dioxybenzoic acid is $C_7H_6O_4+1\frac{1}{2}H_2O$.

Conversion of Oxybenzoic into Protocatechutic Acid, and on the Constitution of the latter.—L. Barth.

Bimethyl- and Biethyl-Protocatechutic Acid.—R. Koelle.—Bimethyl-protocatechutic acid is a solid crystalline substance, not yielding with chloride of iron the reaction protocatechutic acid yields with that compound. It is a strong acid; formula—

$$C_9H_{10}O_4=C_6H_3\left\{\begin{matrix}COOH\\OCH_3\\OCH_3\end{matrix}\right.$$

Some of the salts of this acid are described. The biethyl-protocatechutic acid—

$$C_6H_3\left\{\begin{matrix}OC_2H_5\\OC_2H_5\\COOH\end{matrix}\right.$$

is also a solid body, crystalline, and fusing at 149°.

Conversion of Dichloraceton into Lactic Acid.—E. Linneman and V. von Zotta.—When dichloraceton is submitted in sealed tubes to a temperature of 200° along with water (20 volumes), it is converted into lactic acid. 24 grms. of dichloraceton yielded 5 grms. of pure lactate of zinc.

Stannum Triethyl-Phenyl.—A. Ladenburg.—This substance is a colourless liquid, which is readily oxidised by exposure to air, insoluble in water, readily soluble in ether and absolute alcohol, and boils at 254°; sp. gr. at 0°, 1·2639. Formula, $Sn(C_2H_5)3C_6H_5$.

Silico-Propionic Acid and its Ether.—C. Friedel and A. Ladenburg.—Notwithstanding the high scientific merits of this paper, its contents are not suited for any useful abstraction.

Preparation of Hydrochlorate of Creatinin from Urine.—R. Maly. - Several litres of urine are first concentrated to one-fourth of its bulk. by evaporation, decanted from the sediment of salts, the fluid treated with acetate of lead, filtered, and the excess of lead contained in the filtrate removed by sulphuretted hydrogen, and the filtered liquid nearly neutralised with soda. After this, a concentrated solution of corrosive sublimate is added, whereby a compound of creatinin and mercury is thrown down, which, having been decomposed by sulphuretted hydrogen, is next treated with animal charcoal, and after that evaporated to dryness. The resulting crystalline mass is treated with alcohol, and leaves, on evaporation, creatinin in pure crystalline state.

The American Journal of Science and Arts, August, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Historical Notes on the Systems of Weather Telegraphy and Especially their Development in the United States.—Dr. C. Abbe.—A very excellent account of what has been done in this respect by Americans, to whom, jointly with Europeans, the honour is due of having initiated weather telegraphy, and brought it into practice.

Tornadoes in the Southern States.—H. S. Whitfield.—This essay contains an excellent and clearly-written account of this phenomenon and the causes which produce it.

New Difference Engine.—G. B. Grant.—Illustrated by woodcuts. It treats on the subject of calculating machines.

New Form of Galvanometer.—J. Trowbridge.—Illustrated by an engraving required for the proper understanding of this subject.

Notice of the Meteoric Stone of Searsmont, Maine.—C. U. Shepard.—Account of the phenomena which were observed at the fall, accompanied by a loud report, as of the firing of heavy ordnance, on May 21 last at the locality above named, and exhaustive description of the external physical appearance of a small fragment of the meteorite, the fragments of which, scattered far and wide, are now difficult to find.

This number also contains a number of papers bearing upon natural history.

NOTES AND QUERIES.

Palm Oil.—(Reply to "Chemicus")—As regards the bleaching and deodorising of palm oil, bichromate of potassa and dilute sulphuric acid are used. A work now in the press, viz., Wagner's "Technology" (Churchill), will give you full details on this subject.

Lute for Nitric Acid.—(Reply to "Chemicus.")—Use fire-clay, or better still, kaoline as lute after having thoroughly mixed it with a tolerably strong solution of silicate of soda. Consult the former volumes of the CHEMICAL NEWS, since many lutes and cements are mentioned therein.

Soda from Cryolite.—There appeared in the CHEMICAL NEWS, vol. xxiii., p. 270, an account of the "Manufacture of Soda and Carbonate of Soda from Cryolite," by Mr. J. L. Smith. I have conducted some experiments with a view to making caustic soda liquor from cryolite, observing the directions given in the above process, as described by Mr. Smith. I treated the crushed cryolite with 15 parts of lime, and after boiling for three hours, I found that decomposition had been effected, although I failed to obtain certain results that ought to remain, according to Mr. Smith's calculations. I obtained caustic soda liquor at 22° T., but it was contaminated with alumina in some form. I estimated the alumina, and I found in the gallon of liquor, which consisted of strong caustic soda washings, 585 grs. of alumina. I would feel much obliged if either Mr. J. L. Smith or any other chemist would inform me how to separate the alumina without destroying the causticity of the soda solution. I would like to be informed, also, of the price per ton of cryolite, delivered, say, in London. I have written to Copenhagen for this last particular, but have not had any reply.—W. F. CATCHESIDE, F.C.S.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 618.

ON THE

OXIDATION PRODUCTS OF ESSENTIAL OIL OF ORANGE-PEEL (EAU DE PORTUGAL).*

By C. R. A. WRIGHT, D.Sc., and CHARLES H. PIESSE.

Preliminary Notice.

THE researches of Soubeiran and Capitaine, and those of Dr. Gladstone, have shown that there is contained in oil of orange-peel a hydrocarbon, hesperidene, boiling at 174°, and of formula $C_{10}H_{16}$; the oil employed in these experiments (which was kindly furnished for this purpose by Messrs. Piesse and Lubin, and was believed to be a perfectly pure and genuine article) began to boil at 175°, and almost entirely distilled below 180°; a small amount of non-volatile resinous yellow substance was left in the retort; this was almost insoluble in alcohol when cold, and but slightly so when boiling. After complete expulsion of hesperidene it furnished a soft resin not hardening on standing, perfectly inodorous, of a bitter aromatic taste, and yielding the following numbers on combustion:—

0·3595 grm. gave 0·997 CO_2, and 0·314 H_2O.

	Calculated.		Found.
C_{20}	240	75·47	75·63
H_{30}	30	9·43	9·70
O_3	48	15·10	—
$C_{20}H_{30}O_3$	318	100·00	

No nitrogen was contained in this body, which appears to be related in composition to the hydrocarbon hesperidene; the amount of this resin in the specimen of oil examined was 2·8 per cent.

On re-distilling the hydrocarbon over sodium, scarcely any action ensued; the whole came over between 175° and 177° (uncorrected). Treated with nitric acid and warmed, a powerful action ensues. By employing acid diluted with its own bulk of water, this action is moderated, and may be safely performed in a capacious flask furnished with an inverted condenser, red fumes and CO_2 being copiously evolved. By employing about 1 volume of hydrocarbon, 3 of nitric acid, and 3 of water, and boiling for 1½ hours, a brown resinous non-volatile substance is obtained, which may be obtained pure by boiling several times with water, and drying at 100°, at which temperature it becomes soft; this resin contains nitrogen, and on combustion gave—

Carbon	57·0 per cent
Hydrogen	5·9 ,,

By the further action of diluted nitric acid on this resin, a yellow resin is produced which does not soften at 100°. A specimen obtained by the action of 1 volume of hydrocarbon, 3 of nitric acid, and 3 of water, for 1½ hours, another volume of nitric acid being then added (red fumes having almost ceased to come off), and the whole boiled 1 hour longer, gave these numbers—

Carbon	47·4 per cent
Hydrogen	5·1 ,,

Both this resin and the former brown one appear to contain less hydrogen in proportion to the carbon than the original hydrocarbon, the ratios being—

	Carbon.	Hydrogen.
Hesperidene	100	13·3
Brown resin	100	10·3
Yellow resin	100	10·9

As both contain nitrogen it is possible that they may be derived from $C_{10}H_{16}$ by addition of oxygen and replacement of H by NO_2.

The aqueous acid from which these resins have separated contains much oxalic acid (recognised by combustion, and the behaviour of its calcium and manganese salts, and the explosibility of its silver salt), and apparently also another acid containing nitrogen; for the snow-white oxalic acid prepared by precipitation as lead salt, treatment with H_2S, and several recrystallisations from water, did not give perfectly sharp numbers on analysis, and was found to contain nitrogen by the sodium test.

When hesperidene is boiled *per ascensum* for several hours with dilute potassium dichromate solution, and about as much SO_4H_2 as will saturate the metals of that salt, CO_2 is slowly given off and the chromate is reduced. On distilling the product of five hours' action of 1 part hydrocarbon, 3 of chromate, 1 of SO_4H_2, and 30 of water, an acid distillate was obtained, as well as an oily substance, consisting for the most part of unaltered hesperidene; this oily body, however, although volatile with steam of water, does not wholly volatilise at the temperature at which the original hydrocarbon distils (175° to 177°), a portion being found to boil at a temperature higher than 200°.

The acid distillate, converted into barium salt, gave a product that reduced silver nitrate on boiling, gave a red colouration with ferric chloride, a strong smell of acetic acid on warming with SO_4H_2, and of acetic ether with alcohol and SO_4H_2; the barium salt gave these numbers—

0·2765 gave 0·245 $BaSO_4$ Ba = 52·1 per cent.
Barium acetate requires .. .. 53·7 ,,

From these numbers it appears as though a trace of some acid of higher molecular weight than acetic were produced, especially as probably a little formic acid is also present (from the reduction of the silver nitrate); still the main portion of the product is acetic acid, as is shown by the following analysis of the silver salt obtained by double decomposition of the barium salt by $AgNO_3$, and three re-crystallisations from boiling water.

0·309 gave 0·200 Ag Ag = 64·7 per cent
Silver acetate requires 64·7 ,,

This production of acetic acid does not arise from admixtures of any other body with the hydrocarbons, as might possibly be imagined; in the first place, the high commencing boiling-point of the oil, and its constancy indicates that, at any rate, only traces of any other substance could be present; and, again, the hydrocarbon regained from the oily substance arising from the reaction of the chromate, &c., on hesperidene, furnished more acetic acid on again subjecting it to this treatment.

From the production of acetic acid it appears that the group CH_3 must be present in hesperidene; the following formula—

$$\begin{matrix} CH{\cdot}CH_3 \\ \| \quad | \\ (C_8H_{12}) \end{matrix}$$

possibly may express its composition. It is proposed to follow up these experiments so as to gain some clue to the functions of the other eight carbon atoms, and also to submit other similar substances to examination in the hope of throwing some light on the question of "physical isomerism" in the turpentine group of hydrocarbons.

Manganese dioxide and sulphuric acid do not seem to produce any promising results with hesperidene. The action of potassium chlorate and SO_4H_2 is very marked, a thick resinous substance being formed.

* Read before the British Association, Edinburgh Meeting, Section B.

ON A NEW METHOD OF ESTIMATING ZINC.

By HUGO TAMM.

Of all the metallic precipitates which abound in chemistry there is none which can be compared to hydrated sulphide of zinc. In forming it nature seems to have made a gross mistake which she carefully avoided in the creation of the congener metal *magnesium*, for this abominable compound possesses all the bad or negative properties of all the others, without almost a single good one as a compensation. It settles too slowly in liquors, and when once settled, rises up too quickly if an attempt is made to decant the liquid. It clogs the filters; it passes through the filters; it washes only when it chooses; it oxidises at pleasure, but invariably at the wrong moment; it refuses to oxidise when required to do so; or, when it oxidises, it retains both sulphur and oxygen, seemingly, for the very purpose of leading to wrong results. And yet chemists have, for ages past, submitted to this intractable substance, and all the modes of estimating zinc are founded on the use of sulphide of zinc.

After some efforts, I have succeeded in shaking off the yoke of this capricious mineral tyrant. I am far from saying that this new method is perfect. I shall carefully point out its defects; but, in most cases, where zinc is specially looked for, it is by far the easiest and safest method, and its general convenience is an ample compensation for its defects, which, on the whole, are but slight. After endeavouring, but in vain, to discover some volatile substance which would precipitate zinc completely in acid solutions, or some substance not difficult of separation from any of the elements likely to co-exist with zinc, and precipitating zinc in acid or neutral liquors, according to the rules which I have laid down elsewhere, I was led by analogy to apply the method which answers so well—in default of a better one—for the estimation of magnesia, and I studied the action of phosphates and ammoniacal salts on zinc solutions, and I found that phosphate of soda, for instance, precipitates completely a neutral or slightly acid solution of chloride of zinc, mixed with an excess of chloride of ammonium, in the state of phosphate of zinc and ammonia.

It is this reaction which I have applied with the greatest success to the estimation and separation of zinc in most cases where the estimation of this metal is of any importance.

Preparation of Ammoniaco-Zincic Phosphate—Behaviour and Composition of this Salt—Value of this Mode of Estimating Zinc.

When a solution of zinc in any mineral or volatile organic acid is supersaturated by ammonia, until all the oxide of zinc is dissolved, and when this solution is re-saturated by hydrochloric acid until litmus paper indicates a feeble acid reaction, a double chloride of zinc and ammonium exists in the liquor. If a solution of ordinary crystallised phosphate of soda is added, a voluminous white precipitate of phosphate of zinc is formed, which, if left for a few minutes at a temperature near that of boiling-point of the liquor, soon combines with phosphate of ammonia, and suddenly comes down in the shape of a dense white precipitate, which settles very rapidly.

This precipitate of ammoniaco-zincic phosphate, collected on a filter, can be washed with the utmost facility, in fact, as fast as water can be poured upon it, and it never passes through filters, a most important property. It retains the phosphate of soda and chloride of ammonium in the midst of which it has been precipitated with some strength, and several successive washings are absolutely required to free it from these salts, but eventually the washing is complete. To ascertain this, nitrate of silver acidulated with nitric acid must be used, because the double phosphate retains chlorides with more strength than phosphates. After drying at 100° C., the ammoniaco-zincic phosphate has the constant formula—

$$(ZnO)_2NH_4OPhO_5,$$

and it contains exactly 36·49 per cent of metallic zinc.

From a careful examination of this salt, I arrived at the conclusion that the equivalent of zinc is 32·75. On this point I agree with some analysts, and differ from others. I will not, however, discuss this question, suffice it to say that in complete analyses I have arrived at more exact results in taking the equivalent of zinc at 32·75 than in taking it at 32.

Calcined over a gas-lamp, the double phosphate leaves a residue of pyrophosphate of zinc, $(ZnO)_2PhO_5$.

It might be supposed that zinc could be estimated with accuracy in this salt; but this is not the case, as a loss of zinc is always incurred during the calcination of the ammoniaco-zincic phosphate. On the contrary, the composition of the phosphate of zinc and ammonia, well washed and dried at 100° C., can always be relied upon, and it is from the weight of this salt that the amount of zinc must be calculated.

The precipitation of zinc is complete when the supernatant liquid, mixed with a little excess of phosphate of soda, does not show any bulky precipitate of zinc phosphate; but it is advisable to add at once to the zinc solution a quantity of phosphate of soda, sufficient to turn red litmus paper blue. The liquor is only momentarily alkaline, and it re-assumes its slightly acid or neutral reaction as soon as the double phosphate has come down, so that the precipitation actually takes place in a slightly acid or neutral liquor, a gratifying result.

Should a very accurate estimation of zinc be required, the liquor should be left in a warm place for some ten or twelve hours, when the precipitation of the zinc will be very complete, as might be proved by adding sulphide of ammonium to the filtrated liquor, or sulphuretted hydrogen to the filtrate previously saturated by ammonia, and re-acidulated by acetic acid. In general a trace of zinc is precipitated, for the double phosphate is not absolutely insoluble. For most practical purposes, it is quite sufficient to allow the precipitated double phosphate to rest for about an hour; a very small quantity of zinc will remain in the liquor, from which it can be separated by sulphide of ammonium, but this quantity of zinc never amounts to more than 1-300th of the quantity of zinc precipitated by phosphate of soda, so that it can be neglected, especially if a simple assay of zinc is all that is required.

One of the chief defects of the double phosphate is its propensity to adhering firmly to the side of the flask in which the precipitation takes place. A thin film of this salt coats the glass, and it can be removed only with some difficulty. A glass stirrer, covered at one end with 1 inch or 1½ inches of india-rubber tubing, can be advantageously employed for this purpose. But it is best, after the bulk of the precipitate has been removed on the filter, to dissolve the adhering film in dilute hydrochloric acid, to neutralise by ammonia, to add a few drops of phosphate of soda, to boil, and to add the slight precipitate thus obtained to the main portion already placed on the double filter.

It is sometimes possible to avoid the coating of the glass with ammoniaco-zincic phosphate, by heating the solution almost to boiling-point before adding phosphate of soda; the precipitation in this case is very rapid, and, by taking this precaution, further trouble is avoided. But the chief defect of this mode of estimating zinc is undoubtedly the use of phosphate of soda, a fixed salt, difficult of separation from most substances. Unfortunately, with zinc, there is no choice of precipitating reagents, and phosphate of soda, which must be considered as a very perfect assay reagent, is, from its very nature, a defective one in analytical researches.

If, in similar conditions, carbonate of ammonia is substituted for phosphate of soda, most of the zinc is precipitated as ammoniaco-zincic carbonate, but, even when the operation is conducted with the utmost care, too large a proportion of zinc remains in the liquor. On the other

hand, if carbonate of soda is used, no precipitation of zinc takes place. However, in such cases as this one, the only remedy is a complete knowledge of the behaviour of the reagent employed in given instances, and I shall, accordingly, expose the result of my observations.

Estimation of Zinc in Spelter, and in Salts and Compounds chiefly formed of Zinc and of Oxide of Zinc.

Fifty grains of spelter, and from 50 to 100 grains of the zinc salts or compounds, are dissolved in dilute hydrochloric acid. The solution is supersaturated by ammonia, and a little carbonate of ammonia is added to precipitate any lead which might be present. The addition of carbonate of ammonia, which is essential in the case of spelter, may be useless with other zinc solutions, and, as its effervescence with acids is a source of trouble, it ought to be used only for a purpose. If lime exists in the solution, it is, of course, just as well to get rid of it at once by using a little carbonate of ammonia.

The liquor, separated from any precipitate produced by ammonia or carbonate of ammonia, is re-saturated by hydrochloric acid, until blue litmus paper indicates a feeble acid reaction. The liquor is brought to almost boiling point, phosphate of soda is added until red litmus paper turns blue; the liquor is kept at about the same temperature until the double phosphate has come down; it is then tested for zinc with phosphate of soda, and when the precipitation is complete, the whole is left for some time in a warm place. After filtering, washing, and drying the precipitate, with the precautions already indicated, the amount of zinc is calculated from its weight.

Estimation of Zinc in Blendes.

There are two classes of blendes: those which contain large proportions of iron and small proportions of lead, and those which contain large proportions of lead and small proportions of iron.

Blendes of the first description are attacked by strong nitric acid, and, when the action is over, a large excess of hydrochloric acid is added, then hot water in sufficient quantity to give a clear liquor.

After cooling, the mixture is supersaturated by ammonia. The whole is then boiled and filtered, the precipitated oxide of iron is well washed with dilute ammonia, then re-dissolved on the filter in hydrochloric acid in excess, re-precipitated by ammonia, re-filtered, and well washed.

This second treatment of the oxide of iron is absolutely necessary, but it is most efficient. I have assured myself, by the most careful investigation, that, after this double treatment, the oxide of iron *does not contain a trace of zinc*. This result must be attributed to the large excess of chloride of ammonium formed during both operations.

In this result, I differ from that admirable chemist, H. Rose, who condemns this method of separating zinc from iron. But I suspect that he had not observed the excellent influence of an excess of chloride of ammonium, for if this salt does not exist in the liquor, or if it exists only in small proportion, it is quite true that the separation of zinc from iron by ammonia is impossible.

With the second class of blendes, addition of a large excess of hydrochloric acid is not required. The blende is attacked by strong nitric acid, a little hydrochloric acid is added, then water, then an excess of ammonia, and, lastly, a quantity of carbonate of ammonia sufficient to precipitate thoroughly all the lead. The whole is boiled and filtered, and the precipitate is well washed with water containing a little ammonia and carbonate of ammonia. The precipitate is re-dissolved on the filter in nitric acid, and submitted once more to a treatment similar to the first.

In analyses, the more complicated modes of separation of zinc from iron and lead would have to be resorted to, and, in general, it is best to obtain a solution of zinc as free as possible from impurities. But a solution of zinc which has gone through the usual course of analysis is perfectly fit to be precipitated by phosphate of soda.

The ammoniacal solutions of zinc obtained with either class of blendes, after being carefully neutralised by hydrochloric acid, are precipitated by phosphate of soda, and zinc is estimated as before.

Sometimes either class of blendes contain small quantities of copper, but no notice should be taken of the presence of this metal, which, in this circumstance, is not precipitated with the zinc. However, if it existed in any quantity, it would be best to separate it first, by means of the copper reagent.* Now it just happens, and this is very fortunate, that nickel, cobalt, and manganese, which would trouble the estimation of zinc by this process, seldom, if ever, accompany zinc in blendes; but, should they exist in small quantities, their presence could be neglected, as they would remain in the solution. But this process must not be used in cases in which nickel, cobalt, and manganese, exist in any quantity, unless these three metals are first separated from the zinc.

Estimation of Zinc in Calamines.

Calamines are attacked by hydrochloric acid, and the mixture of gelatinous silica and of chlorides thus obtained being evaporated to dryness, re-acidulated by hydrochloric acid, diluted with water, and filtered, the filtrate can be submitted to two successive treatments with hydrochloric acid and ammonia, as in the case of blendes of the first class, and zinc estimated as in blendes. But, however carefully the operation is conducted, it is not possible to obtain a silica free from oxide of zinc, and it is by far the best to have recourse to the following process:—

Fifty grs. of the calamine are attacked in a platinum vessel, conveniently large, by a mixture of equal parts of hydrofluoric and hydrochloric acids. When the solution is completed, dilute sulphuric acid (half water and half sulphuric acid) is added in slight excess, and the mixture is slowly evaporated, until white fumes of sulphuric acid begin to come off. After cooling, water is added, and also a large excess of hydrochloric acid. The solution, which ought to be quite clear, is transferred to a flask, and there submitted to the two successive treatments described in the case of blendes of the first class, and zinc is estimated exactly as in that instance. Or the solution may be submitted to a regular analytical process.

When lime is present, it is advisable to separate it first by means of a little carbonate of ammonia. But, if magnesia exists, even in pretty large quantity, this substance is nicely separated from the zinc. It remains in the solution, in which it can be estimated as phosphate of magnesia and ammonia by addition of ammonia. However, if it existed in large proportion, it would be best to separate it, first by adding phosphate of soda to the ammoniacal solution of zinc; after the separation, zinc could be easily precipitated by neutralising the filtrate by hydrochloric acid.

These notes, however, apply much more to what might happen than to what actually occurs in most cases.

Estimation of Zinc in Brass.

The liquor from which copper has been separated by the copper reagent,† and resulting from the solution of 20 or 50 grs. of brass, is saturated at once, and without any previous preparation, by ammonia in excess, and this mixture neutralised by hydrochloric acid is precipitated by phosphate of soda and zinc estimated as stated. Or, better still, the liquor from which copper has been precipitated by the copper reagent, and resulting from the solution of 100 grs. of brass, is boiled to get rid of sulphurous acid, then submitted to sulphuretted hydrogen, whereby lead, arsenic, antimony, &c., are precipitated, then filtered, boiled once more to get rid of sulphuretted hydrogen, oxidised by nitric acid, saturated by ammonia, which precipitates small quantities of iron, filtered, and the filtrate neutralised by hydrochloric acid is precipitated by phosphate of soda.

* CHEMICAL NEWS, vol. xxiv., p. 91.
† *Ibid.*, p. 92.

As it is quite as easy to estimate large quantities of zinc as small ones by this method, the more zinc there is in a liquor the more accurate is the estimation of this metal.

Estimation of Zinc in German Silver.

This method cannot be applied to the estimation of zinc in this alloy unless nickel is separated immediately after copper, and zinc left alone in solution.

General Observations.

In the course of an estimation of zinc by this method, the chemist can depend on the result, whenever he can obtain the dense precipitate in the circumstances previously described; for whenever the substances which follow zinc in an ammoniacal solution exist in large proportions, the precipitate of phosphates remains bulky, and the dense precipitate cannot be obtained.

Cobalt, it is true, is precipitated freely along with the zinc, but, in this case, cobalt imparts a beautiful blue colour to the double phosphate, and reveals itself at once.

In the same circumstances, nickel would impart a greenish tinge to the precipitate.

I need scarcely remark that it is just as well to examine qualitatively the double phosphate with which zinc has been estimated. It should be free from lime, magnesia, nickel, cobalt, and manganese.

But all these observations will seldom find applications, and are introduced here only to meet possible but not actual cases.

When zinc forms only a small fraction of the substance analysed, the ordinary methods of separations ought to be, and generally must be, resorted to, but, when once isolated, zinc can be with advantage estimated as ammoniaco-zincic phosphate.

Such is, with all its advantages and all its imperfections, the method which I propose for the estimation of zinc. I hope that a happier hand will soon find a reagent volatile, if possible, or easy of separation with most substances, precipitating completely zinc in acidulated solutions of zinc and ammoniacal salts. Here is the problem; may the solution soon be discovered.

Analytical and Chemical Notes, Derived from the use of Phosphate of Soda in the above Process.

Estimation of Manganese.—If there was any difficulty about the estimation of manganese, or if excellent methods for the estimation of this metal were not as numerous as they are, I should publish a lengthy article on the following process, which can be safely recommended especially for the assays of manganese ores.

The hydrochloric solutions of manganese, freed from oxide of iron generally existing in them, by means of succinate of ammonia, are mixed with an excess of chloride of ammonium. An excess of phosphate of soda is added, and the mixture is heated to almost boiling-point. Manganese is precipitated completely in the state of phosphate of manganese and ammonia. This precipitate is well washed (it washes very easily) and dried at 100° C. Its formula is then $(MnO)_2NH_4O,PhO_5 + 2HO$, and it contains exactly 29·78 per cent of manganese.

The chief advantage of this mode of estimating manganese over the usual method is that it is estimated in one series of operations, while by the ordinary process it requires two.

This process is as nearly as possible identical with the above process proposed for the estimation of zinc, and nearly all I have said in the former pages I could repeat here.

Ammonio-Phosphates.—Most of the neutral solution of oxides soluble in ammonia, mixed with an excess of chloride of ammonium, are precipitated by phosphate of soda, and when the mixture is boiled most of the ammonio-phosphates crystallise. Some of them are very remarkable. The phosphate of manganese and ammonia thus prepared (the double phosphate of the above process of estimating manganese) forms crystalline scales, of a silky appearance, soft to the touch, and of a beautiful flesh-colour.

The phosphate of ammonia and cobalt forms beautiful crystals of an indifferent pink colour, but when this substance is calcined at a low temperature, phosphate of cobalt of an admirable deep blue colour is obtained; it preserves the shape of the original crystals, and forms a beautiful substance pseudo-crystallised.

A beautiful series of blues can be obtained by precipitating, by phosphate of soda, chloride of zinc mixed with chloride of ammonium, and containing variable quantities of chloride of cobalt.

The phosphate of ammonia and protoxide of iron is precipitated in the same general conditions, in the form of silky crystalline scales, very soft to the touch, and which possess a most remarkable appearance. Their colour, which I cannot very well describe, is analogous to that of certain greenish micas, and altogether very strange.

Chloride of ammonium is the crystallising agent in the preparation of these salts, remarkable in so many respects.

ON RECENT INVESTIGATIONS AND APPLICATIONS OF EXPLOSIVE AGENTS.*

By F. A. ABEL, F.R.S., Treas. C.S.

(Concluded from p. 138).

The discovery made in 1864, by Mr. Alfred Nobel, that the explosive force of nitro-glycerine can be fully developed without any strong confinement of the charge, through the agency of a detonation, appeared to give that substance so great and well-founded a claim to superiority over gun-cotton and other explosive agents, in connection with some of their applications, that the pre-eminence which this liquid enjoyed for a time as an explosive substance of quite exceptional properties almost equalled the dread of its dangerous character inspired by the succession of fearful accidents which inaugurated its employment on an extensive scale. Not long afterwards, however, it occurred to my assistant, Mr. E. O. Brown, to try whether compressed gun-cotton could not also be violently exploded in the open air, through the agency of a detonation, and a result was obtained quite similar to that furnished by nitro-glycerine. I was led by this observation to institute a systematic experimental inquiry, with a view of throwing light upon the nature and cause of the remarkable phenomena exhibited by these two bodies, and I soon found that *all* explosive compounds and mixtures, even down to gunpowder, are susceptible of violent explosion by means of a detonation, though the nature and force of the required detonation vary very considerably with different explosive substances. The results arrived at by a careful inquiry into the conditions to be fulfilled in determining the detonation in open air of these compounds and mixtures, and of the operating causes, physical and mechanical, which tend to modify the character of the phenomena produced upon their exposure to heat, concussion, &c., are detailed in the *Transactions of the Royal Society*—their present discussion is precluded by the great length which this lecture has attained. It may, however, be stated in general terms, that although the amount of mechanical force developed by the initiative detonation, and the suddenness of its operation, play most important parts in determining the violently sudden metamorphosis of the substance submitted to their influence, neither the severity nor suddenness of the blow or concussion, nor the heat developed by it, nor the peculiar nature or comparative instability of the particular explosive body operated upon, suffice individually or collectively to account for all the several phenomena of detonation; but

* A Lecture delivered to the Members of the British Association at Edinburgh, August, 1871.

that some yet unexplained peculiarity in the initiative concussion employed, and probably some physical relation or antagonism between it and the particular concussion produced by explosion of the substance operated upon must, in many instances, contribute to produce results, positive and negative, which can be satisfactorily explained by simple reference to the operation of mechanical force, and consequently of heat. In illustration of this it may be instructive to give two examples. The detonation of compressed gun-cotton is accomplished by the explosion of 0·32 grm. (5 grains) of confined mercuric fulminate, placed in contact with the mass, but it requires ten times that quantity of the violent explosive agent, chloride of nitrogen, also confined, to produce the same result. Again, the mechanical force exerted by the explosion of nitro-glycerine is fully equal to that developed by the mercuric fulminate, yet a quantity of nitro-glycerine, about seventy times greater than the minimum of the fulminate required to detonate compressed gun-cotton, fails, when exploded in contact with the latter, to produce any other result than the complete mechanical disintegration of the mass.

With regard to the general manner in which a detonation action determines the violent explosion or sudden chemical disintegration of such a substance as gun-cotton, the similarity of its operation to that of a blow is readily demonstrated by many and simple experiments, for a description of which I must refer to my paper presented to the Royal Society in 1869; one or two may, however, be mentioned which have been made with gun-cotton, and which probably illustrate the subject sufficiently for present purposes. The heat developed in a mass, when submitted to a blow, depends upon the resistance which its particles oppose (by reason of its rigidity or solidity) to the motion of the body striking it. Repeated blows may be required to explode a detonating substance placed in the form of loose powder upon an anvil; the force being, at first, in part expended in compressing the particles into a compact mass. When no longer free to move, the resistance they oppose to the force applied determines the sudden transformation of the latter into heat to a sufficient extent to bring about the detonation of the substance struck. If, in the case of gun-cotton, the force developed by a detonation, even of a powerful character, is allowed to operate upon the material in a loose flocculent condition, the latter is simply dispersed; again, if the gun-cotton be only lightly compressed, a much more powerful detonation is required for its explosion than if it be in a very compact condition; and if the mass of the highly compressed material be only very small, it cannot be detonated by the means which are successful with larger masses, unless special precautions be taken, by fixing it rigidly to the detonating fuse, to prevent its being dispersed by the force which the explosion of the latter exerts. These facts, when compared with the following experiments, demonstrate that the action of a detonation in developing the violent explosion of the substance upon which it is allowed to operate, is that of a very sudden blow given to some portion of a mass, the particles of which are in a condition to resist the motive or dispersive power of the mechanical force applied. A bullet from a Martini-Henry rifle was fired at a distance of about 50 yards, against a slab of compressed gun-cotton, 0·75 inch thick, and 3·75 inches in diameter (weighing 4 ounces), freely suspended in air by a string; the gun-cotton was simply perforated by the bullet. A similar result was several times obtained with slabs of gun-cotton of the same dimensions, and with others double the thickness. On making the experiment with a slab of three times the thickness, the gun-cotton was inflamed but not detonated by the impact of the bullet. The mass was, in this instance, of sufficient thickness to offer considerable resistance to the penetrative power of the bullet; the passage of the latter was, therefore, retarded to such an extent as to give rise to the heating of the opposing gun-cotton particles up to their inflaming point. This experiment was repeated with the same result, but when a bullet was fired against a piece of compressed gun-cotton four times the thickness of that first employed, and weighing one pound, the result was detonation of the mass.

It need scarcely be stated that the detonation of a large quantity of an explosive body is accomplished by the initiative detonation of a very small portion of the mass; this is the case even if the material is arranged in the form of a train of considerable length, the detonating fuse being applied at one extremity. Rows of gun-cotton disks from 3 to 5 feet in length, with intervals of 0·5 inch and 1 inch between the individual masses, have been detonated in this way. There is, however, a limit to the distance to which a detonation will be transmitted along a row of spaced disks, the limit being determined by the particular weight of the masses employed; if it be exceeded, those masses which are at the farther extremity will be inflamed and scattered, instead of being detonated. A few preliminary experiments have been made with the view of determining, by means of the chronoscope, the rapidity with which detonation progresses along a row of gun-cotton disks. This will no doubt vary with the sizes of the masses; in an experiment with disks weighing 2 ounces each, placed in a row without intervals, it was found that the detonation extended to 3 feet in about 1-5000th part of a second.

Time will not permit of the discussion of many other points of scientific interest connected with the detonation of compressed gun-cotton and of other explosive agents, but it will probably prove interesting if a few illustrations are furnished, in conclusion, of the practical value of this mode of developing the force of explosive agents.

The necessity for confining gunpowder and other explosive materials in strong receptacles, for the purpose of developing their explosive force, is greatly reduced, and is, indeed, entirely dispensed with in the case of charges fired under water, when detonating fuses are used as the exploding agents. Thus, if a quantity of gunpowder which, when enclosed in a strong iron receptacle, will be completely exploded, producing a particular destructive effect when fired in the ordinary way, is confined in a thin glass vessel, or in a bag of waterproof material, the receptacle will be burst open upon the first ignition of the charge, and a large amount of the powder will be dispersed in the water; but if a detonating fuse be employed to fire the charge contained in the thin envelope, the powder will be completely exploded, the destructive effect produced being at least as great as that of the charge fired in the strong vessel by the ordinary method. This result is of very great importance, because, in employing submerged charges of gunpowder or other explosive agents for purposes of demolition, or as submarine mines for war-purposes, it is no longer necessary to use very strong and cumbrous receptacles for the purpose of obtaining the desired result; their strength need only be sufficient to insure the perfect exclusion by them of water from the charge at the depth of immersion at which it has been employed. In the recent demolition of the wreck of the "Golden Fleece," off Cardiff, by the Royal Engineers, large charges (500 lbs.) of gunpowder were simply enclosed in waterproof bags and exploded with detonating fuses. The results produced with these were quite equal to those obtained with similar charges enclosed in strong iron cases.

Masses of hard material, of great size or strength, such as blocks of hard rock, large iron castings, or thick bars of wrought-iron, may be broken up by simply placing upon one of their surfaces a comparatively small charge, quite unconfined, of compressed gun-cotton, or of a nitro-glycerine preparation, and exploding it by means of a detonating fuse. In such operations it is obvious that the destructive effect of the detonation will be increased by covering the charge to be exploded by sand or other material, which will act as tamping; but, in hurried operations, results may be obtained with either of the materials specified, by detonating them when freely exposed to air, which could not

have been produced by previously known modes of using explosive materials. The demolition of stockades, bridges, and other structures, which it may be desirable to destroy or render useless as expeditiously as possible, in the course of military operations, may also be effected with much greater ease, rapidity, and certainty, by the aid of detonation, than by the old method of operation; and the ease and safety with which compressed gun-cotton may be applied to these purposes has been demonstrated by numerous experiments instituted by the Royal Engineers. In mining and quarrying operations, the process of hard tamping which is indispensable in connection with the ordinary method of blasting, may be dispensed with by application of gun-cotton and of nitro-glycerine preparations, which are more readily exploded, with full destructive effect, by detonation, than other explosive materials at present known. A laborious and often very hazardous operation may thus be dispensed with.

For the hasty demolition of buildings, and of military work, such as casemates, magazines, or forts, the explosion by detonation affords most important facilities, reducing the difficulties, danger, and cost of such operation to a minimum. Some results obtained in this direction by the Royal Engineers with compressed gun-cotton may be quoted in illustration of this. It was desired to destroy a counterscarp gallery (forming part of the old works at Portsmouth), which was 250 feet long, and 7 feet wide. Its front wall was from 5 feet to 5 feet 9 inches thick, and was pierced with nineteen loopholes. It was roofed over by an arch 18 inches thick (from over which the earth had been removed), and its total internal height was 7 feet 4 inches. At either end there was an opening, closed by a wooden door, which was protected by an iron grating composed of one-inch bars, 4 inches apart. It was proposed to submit this counterscarp to a succession of small experiments, and, in the absence of any experience of the effects of gun-cotton applied in the interior of a building, it was decided to suspend 60 lbs. against the wall, under the haunch of the arch, placing them in three charges near one extremity of the gallery. The simultaneous detonation of these charges accomplished the destruction of about 140 feet of the gallery—about 114 feet being actually demolished. But this was only part of the damage produced. The violent concussion at the other end of the gallery, where the column of gas was checked in its escape, occasioned the destruction of about 80 feet of this part of the counterscarp, and the bars of the iron grating, by which the exit was closed, were bent and twisted into fantastic shapes, and hurled to a distance of about 60 yards. This long gallery was thus rendered entirely useless, and the greater part of it destroyed, by the detonation of 60 lbs. of compressed gun-cotton; and there is little doubt that, had the same quantity been lodged in the centre instead of at one end, the gallery would have been completely demolished.

Another illustration of the simple, rapid, and effectual manner in which the demolition of structures of great strength may be accomplished by the detonation of compressed gun-cotton, was furnished by the destruction of a Martello tower near Rye. This structure, of circular form, was built of brick, the wall being 12 feet thick on the sea side, and tapering to 7 feet 6 inches on the land side. It had two window openings, and one door opening, and its cubical contents were 7600 cubic feet. On the basement of this tower 200 lbs. of compressed gun-cotton were placed in three piles, freely exposed, which were arranged to be fired simultaneously. Their explosion caused the upper portion of the tower, with the roof, to rise gently a few feet in the air; the walls turned over, outwards, and the upper part subsided to the ground; the demolition of the tower being most complete, while not a brick was projected 50 yards from the spot. The entire operation was accomplished by two or three persons, within one hour of their appearing upon the ground. A second tower was subsequently demolished with 184 lbs. of gun-cotton, with similar results. It was calculated, from existing data, that at least 1200 lbs. of gunpowder must have been employed to produce similar results.

In this sketch of the recent progress which has been made in the application of explosive substances, many points of interest and importance have unavoidably been passed over; sufficient, however, will have been said to show not only that the production and utilisation of these powerful agents of destruction, and these indispensable auxiliaries in the development of industrial resources, have been advanced in an unprecedented manner within the last few years, but also that very much remains to be learned regarding their nature and operation and the conditions to be fulfilled in their most efficient application in many important directions.

NOTES FROM THE INTERNATIONAL EXHIBITION OF 1871.

(Concluded from p. 142).

Who has not asked the question—What is ozokerit? Written on the knife-board of omnibuses—staring from street corners and hoardings, even on the back of one's programme at concert or the theatre, was ever present the one word—ozokerit. But the mystery has this some time been cleared up satisfactorily; the more so as the production of ozokerit appears to open an extensive industry in the view, that for India and other hot climates, a candle having a high melting-point, and manufactured at a lower price than wax, is an absolute necessity. Ozokerit in candle manufacture seems to be offering formidable competition to paraffin. It exists in considerable deposits in Galicia, Hungary, and in Russia. In the latter country crude candles were manufactured out of the native material for the use of the miners; but it is only within the last year that it has been successfully dealt with by Messrs. J. C. and J. Field, who exhibit a series of specimens (7465-67) of native ozokerit, of the refined material, of candles, and other products obtained from this remarkable mineral. Native ozokerit is of a waxy consistency and foliated structure, varying in colour from pale yellow to dark brown, with sometimes a green tinge, and containing 85·75 per cent of carbon, and 15·15 per cent of hydrogen. It also contains a natural oil (7465) applicable to illuminating purposes. For the manufacture of candles the mineral is first carefully distilled, the product being mixed with an oil and formed into cakes under powerful pressure. These cakes are treated with sulphuric acid to remove the last traces of oil, and the melted material washed and filtered through animal charcoal. Candles made from this pure ozokerit have a melting-point between 59° to 61° C., and greater illuminating power than any other candle known. Professor T. C. A. Brock, of Denmark (7626), exhibits some stearic acid, the result of a new process of manufacture; but no details are given.

We now come to the consideration of the metals and metallic preparations exhibited. Messrs. Winsor and Newton contribute (7562) a series of pigments of extraordinary beauty prepared from thallium. The specimens include several shades of yellow and orange-red prepared from thallium chromates by the wet way; and green colours, also constituted of thallium and chromium, with a dark brown, a sulphide of thallium. Mr. J. Johnson (7496) exhibits black, grey, brown, and yellow colours prepared by calcining shales at different degrees of heat. These pigments are intended for cheaply coating iron. Messrs. Johnson and Matthey (7495) contribute specimens of magnesium illustrative of the process of manufacture. Magnesium, though classed with the alkaline earths, more closely resembles zinc in its principal properties. Its chief use is as an illuminating agent for photographic or signalling purposes; for the former it is well adapted, the

light being rich in chemical rays. Messrs. Walker, Campbell, and Co. (7428) exhibit specimens of block-tin pipes encased in lead, intended for the conveyance of soft water, which acts corrosively upon lead pipes. This mode of protection is the invention of Mr. Haines. There are also exhibited specimens of lead pipes (7429) coated externally with tin to afford protection from corrosion when laid in damp earth. Mr. J. F. Allen exhibits (7414) a series of alloys of copper with different proportions of manganese, manufactured under his direction at the works of Messrs. Newton, Keats, and Co., of St. Helens. Bergmann appears to have been the first to produce alloys of copper and manganese in 1774, and he describes them as being extremely malleable and ductile. In 1823 numerous experiments were made in Berlin, and in 1826 there were sold, under the general name of "*Weisskupfer*" alloys of copper and zinc containing manganese. Erdmann analysed a teaspoon composed of this alloy, and obtained it from a firm who kept their process secret; it was found to consist of 57·1 per cent of copper, 23·2 of zinc, and 19·7 of manganese. Messrs. Evans and Askin appear to have been the first in this country to manufacture alloys of copper, zinc, and nickel with manganese; and in 1850 Dr. Percy and Mr. Higgin gave much attention to the subject. The difficulty of manufacture laid in the re-melting of the alloys, in consequence of the tendency of the manganese to oxidise out; but Mr. J. F. Allen has succeeded in the production on a large scale with greater uniformity than hitherto, and, by dispensing with the use of plumbago crucibles, at a considerably reduced expense. The alloys are produced by heating mixtures of charcoal, cupric oxide, and manganese carbonate in a reverberatory furnace with small coal as fuel. A non-oxidising flame is obtained by employing Siemens's arrangement. The alloys exhibited contain 5 to 25 per cent of manganese. A copper-zinc alloy with 15 per cent of manganese, termed "manganoid," is proposed as a substitute for German silver. Spoons, &c., of this alloy are exhibited, as well as some very tough wire drawn from an alloy containing 23 to 25 per cent of manganese. Alloys of copper and tin with manganese are proposed by Mr. Allen as a gun-metal.

The British Seaweed Company exhibit a complete series (7425) of the products obtained by the distillation of seaweed at their two extensive works in the Hebrides. These works are lighted by the gas obtained from the seaweed. Mr. Stanford's method is of course that employed, and as illustrative of the extent to which it is now worked it may be stated that the following numbers represent the annual production of potassium-salts at the Company's factories:—Carbonate, 600 tons; bicarbonate, 30 tons; chlorate, 50 tons; iodide, 23 tons; and bromide, 12 tons. Besides these products and the illuminating gas, there remains the charcoal, in some instances an excellent substitute for animal charcoal. The cheapness of seaweed charcoal is much in favour of its employment as a deodoriser of offal of all kinds; and Mr. Stanford shows that it can be used in the place of earth in the dry-closet system with great advantage, especially in dealing profitably with the *excreta* of towns. Employing seaweed charcoal as the starting point, he submits the product of the dry closets to distillation, and re-applies the residual charcoal to deodorising purposes. Mr. Stanford exhibits (7547) tar, calcium acetate, ammonia, and ammonium salts, as the marketable products resulting from the distillation. Glasgow is the first to take up the system which has been worked out by Mr. Stanford with such great labour. Crease's "Patent Cleansable Tank Filter," exhibited by Messrs. Burney and Co. (7479), designed for use on board ship, embodies another efficient sanitary application of charcoal.

M. Ludwig Mond exhibits specimens (7513 and 7628) of the products of the utilisation of alkali waste. M. Mond brought his present process into practice in 1863, and it is now that adopted for recovering the sulphate in most of the German and in two of the largest French works. The process consists in at once submitting the waste, in the same tanks in which the separation of alkali by lixiviation has been accomplished, to successive treatments with air, and lixiviations for the removal of the resulting soluble sulphur-compounds. After the soda-liquor has been drawn off from the residuum, air is made to penetrate the latter by being forced through perforations in the false bottom of the tank. The residue is then lixiviated, the extract or sulphur liquor containing principally calcium hyposulphite, bisulphide, sulphydrate. When sufficiently concentrated, the liquor is mixed with chlorhydric acid to precipitate the sulphur, no sulphuretted hydrogen being evolved, because the liquor contains an excess of calcium hyposulphite. The precipitated sulphur is then transferred to iron vessels, in which it is melted by injected steam. M. Mond exhibits a diagram of the arrangement in actual use for extracting sulphur from 300 tons of alkali waste weekly. This exhibitor also contributes a model (7602) of a simple form of furnace, devised by MM. Helbig and Horsenclever, for effecting the roasting of ores by a continuous operation, which is accomplished through the agency of an inclined plane, or of several such planes, inclosed in the furnace. These planes are fixed at the natural angle presented by the sides of a heap of ore, which descends gradually and regularly as the material is removed from the bottom of the furnace. These furnaces are especially adapted for the roasting of small ore, and are now advantageously employed for this purpose in many German works. In some cases they are connected with the roasting furnaces for pyrites and blende, so that the heated gases from these are passed into the sloping furnaces, assisting in the heating.

Few of the inventions are of greater practical importance than the "selenitic mortar" (7519) exhibited by Col. H. Y. D. Scott, C.B., R.E. Some sixteen years ago Col. Scott first noticed the influence of a small proportion of calcium sulphate, or the sulphuric acid it contained, upon the setting qualities of inferior limes. It was found that by intimately mixing as little as 5 per cent of plaster-of-paris with freshly-burned fat lime, the heating upon the addition of water was presented, and the product hardened after a time. The sulphuric acid or calcium sulphate is first mixed with the water to be used in making the plaster or mortar; the lime is then added, and the whole ground to a creamy paste, which is mixed with the requisite proportion of sand for the production of a mortar or plaster. Five or six parts of sand may be used to one of lime for producing rough plaster or mortar, being being nearly double the proportion employed in the ordinary method of mortar-making, when the lime is allowed to slake. The saving is therefore very considerable. Mr. G. R. Redgrave (7520) exhibits a form of mill adapted to the rapid preparation of selenitic mortar. The only other cement exhibited is a specimen of Portland by Mr. Wedekind (7559) obtained by a new process from Hofmann's kiln; but there are no details afforded.

In the Chemical Stoneware Department Mr. Bailey and Messrs. Doulton and Co. are the only contributors of any importance. Mr. Bailey exhibits some large acid tanks, receivers, condensing worms, and other vessels. Messrs. Doulton and Co. have the finest collection of chemical ware, among which are two acid force-pumps of very superior finish. This firm also excels in the fire-clay department, to which they contribute an enormous plumbago crucible, free from flaws, nearly 6 feet in height, and 4 feet in diameter at the mouth; it is asserted to be capable of melting more than 13,000 lbs. of metal. There is also shown a fine collection of muffles for glass-staining and other purposes. The Patent Plumbago Crucible Company also exhibit a most valuable and interesting assortment of crucibles, assay pots, &c.

The conclusion must now be drawn, for we have considered nearly all the chemical products exhibited, and it will be seen that certainly the results of this year's exhibition must be judged not by the number, but by the intrinsic worth of the inventions.

CORRESPONDENCE.

ALUM IN BREAD.

To the Editor of the Chemical News.

Sir,—I had occasion some few months since to determine the purity of a number of samples of bread, and among other experiments was used the test mentioned by Dr. Moffat in his Glasgow Lecture, and referred to by Mr. Horsley in your last issue.

Some of the specimens gave a purple colour very quickly, but the majority gave a fine blue, several of them within a little time after application of the solution, whilst in others the colour only became developed after an interval of several hours, or on standing over night.

Experimental specimens of flour and of bread, to which alum had been purposely added, gave in each case a purple colour.

I am quite unable to assign any practical value at present to these results, for I have not further examined them. It may, however, be as well to note that all the blue specimens contained potatoes, and that a drop or two of logwood solution gave a blue colour to the ordinary water of the town, which contains a trace of iron, and to this also, possibly to the earthy salts, I presume the change of colour in the water is due; whether any similar influence is exercised by the test over water and salts in the loaf I am unable to state.

So far as my personal knowledge goes, these logwood tests for determining the presence or absence of alum in bread and flour are by no means quite satisfactory.—I am, &c.

Richard Weaver.

Leicester, Sept. 20, 1871.

RING VORTICES IN WATER.

To the Editor of the Chemical News.

Sir,—In the note I addressed to you on the 5th of August last, as a postscript to my paper on the above subject, which was published in your issue of the 4th of August last, I referred to the previous labours of Mr. Charles Tomlinson, as described by him in the *Philosophical Magazine* for 1864. Mr. Tomlinson in those papers refers to the still earlier labours of Professor W. B. Rogers, of Boston, U.S., as described by him in the *American Journal of Science* for September, 1858. After some trouble, I have procured a copy of this journal, and it is now before me. Professor Rogers has done so much, and that so well, as regards these rings themselves, that I venture to ask you to reproduce some of his remarks and figures.

He does not allude to the secondary rings or discs, nor to the currents caused by the passage of the rings through the fluid, and as these secondary phenomena, *i.e.*, the "tendency to form from merely straight currents structures at intervals in planes at right angles to the currents," have been suggested by me as probably throwing light on the formation of clouds in strata, I have also to ask you to reproduce a communication from a friend, with whom I have often discussed the question as to why clouds floated in strata, who is conversant with many of the effects of cloud perspective, and who saw, I think, in actual progress, the phenomenon of a stratum of cloud giving out a column or currrent, and the conversion of that current into another stratum. My friend's communication was written to me before he had heard of any of the experiments now noticed. At our last disscusion on cloud strata he had related this circumstance to me, and when I saw the rings and their sequels, his account at once came to my remembrance, and, without telling him for what purpose I required it, I asked him to put in writing his recollection of the facts. Professor Rogers' most characteristic sketches are, I think, the following:—Fig. 1, the commencement of a smoke ring, and Fig. 2 the section of "a continuous and moderate blast." He gives no drawings of liquid rings, but describes very suitable apparatus for their production, and traces most clearly the resemblance between the two classes of phenomena. The remarks of his to which I attach most force are perhaps the following, but it is not an easy task to avoid much fuller quotations. Speaking of smoke rings, "we observe the ring to be made up of a coil of cloudy air—between the folds of which is rolled up a similar coil of transparent atmosphere," Fig. 1. Referring to his figure reproduced in Fig. 2, "They (the regular alternations) at least furnish conclusive proof that even a large stream of gas discharged under steady pressure does not flow with continuous uniformity, but becomes the seat of periodical movements at equally recurring intervals." Speaking of a liquid ring, "It is thus identical with the rotation of a gas ring impelled in a descending direction." "The liquid ring, moreover, resembles that of gas in being composed of a coil of coloured fluid enfolding a parallel uncoloured coil." Too long for extract is the account of Professor Rogers's experiments in producing smoke rings from soap bubbles filled with smoke by piercing the bubble in various positions, and expelling its contents through this opening by means of the contraction of the bubble film. In fine, simply regarding the experimental formation of the rings, Professor Rogers has left little undone. Mr. Charles Tomlinson has shown that various effects result when dissimilar liquids are used. I have tried to show the alliance of this kind of phenomena to all cases of fluids in motion, when one part of the mass moves with a different velocity to the rest. To this mode of motion I attribute many chemical results now attributed to "diffusion." If chemists will repeat these experiments and consider what must happen when fluids are acting on each other, I think (at all events amongst technical chemists, the body to which I belong), "diffusion" will diminish in importance and mechanical action, *i.e.*, mode of motion will take its place.

Fig. 1.

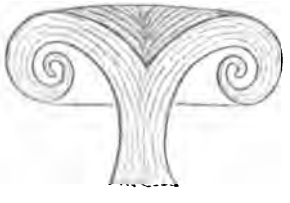
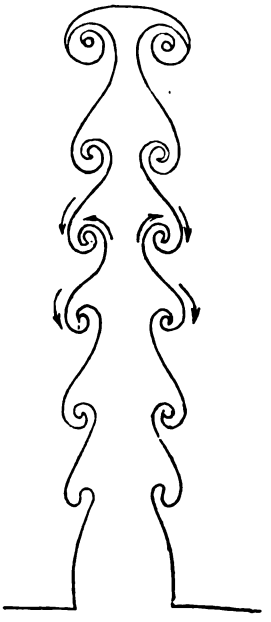


Fig. 2.



I annex my friend's letter.—I am, &c.,

Henry Deacon.

Widnes, September 4, 1871.

Copy of Letter from Mr. Samuel Hall to Mr. Henry Deacon.

"41, Barnsbury Street, London, N.
"August 1, 1871.

"It was about this time of year 1869 that I saw the cloud in the act of transferring itself from one strata of

the air to a higher one. The centre of the cloud was about two or three miles north of Lausanne, on the Lake of Geneva, no mountains sufficiently near to interfere with the process. Time about 11 a.m., a fine day, with a few clouds, which eventually disappeared. The cloud particularly noticed was a cumulo-stratus, say, two or three miles long, and floating from 3000 to 4000 feet above the surface of the ground. When first seen there was a kind of pillar of cloud rising rapidly from the centre of the mass. This took my attention, and I observed it for a few minutes. The pillar seemed to stop rising almost immediately after I commenced looking, and there accumulated a denser head, which began spreading itself out horizontally.

"Unfortunately, owing to the direction of our walk, our backs were turned to the cloud, and my companion was not particularly interested in it. However, from time to time I turned and watched it till in about half an hour I should think, but am uncertain with regard to this, it had assumed the shape of a dumb-bell with very flattened heads, at least half the cloud having attained the higher level, which I should very roughly estimate at another 4000 feet.

"I will just add that, although there was no mem. taken at the time, I have no doubt of the general accuracy of this description; also that perspective could not have deceived me very much. Though looked for, I could not detect any twisting motion in the ascending pillar."

"(Signed) SAMUEL HALL.

"The accompanying are rough sketches of first and last appearance.

FIG. 3. (As first seen).

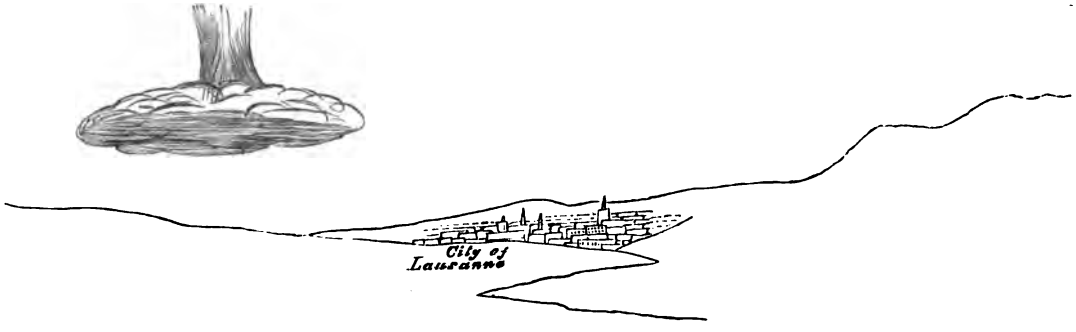
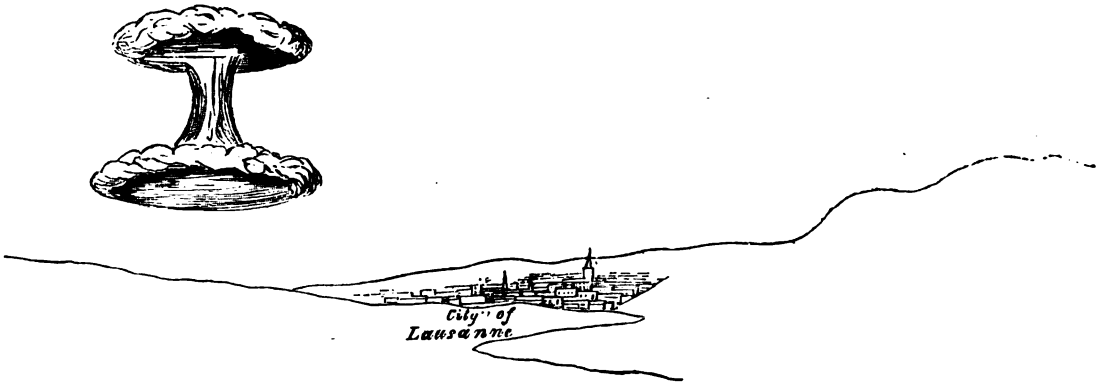


FIG. 4. (As last seen).



MAGNETIC MOTIVE POWER.

To the Editor of the Chemical News.

SIR,—In the postcript to my letter last week, by some clerical or other error, the numbers were given incorrectly. I intended to write that 1,199,700 foot-pounds of work were produced by 7 ounces (avoirdupois) of iron.

It may be satisfactory to describe how the figures were obtained. Two electro-magnets fixed on an axle were made by commutators to rotate in front of a fixed electro-magnet. Revolving fans were placed on the axis, which, by the resistance of the air, reduced the speed to an average of 93 revolutions a minute. When the electrical current was cut off, it was found that a weight of 86 pounds fastened by a cord to an axle one inch in diameter, produced and sustained the same rate of revolution; in ten hours, seven ounces of iron were consumed, so that my calculations were purposely kept below the mark in order to be on the safe side.

The result was verified and confirmed by making the negative power, when the fans were removed, raise at the same rate of revolution six pounds fastened by a cord to an axle of one foot diameter, in addition to the friction.

The potential of the battery was about ⅓ths that of a Grove. Joule calculates the utmost *possible* force of a grain of zinc in a Grove battery at 267 foot-pounds, and the utmost *practicable*, half that, or 134 *foot-pounds*. *Here* the work of a grain of iron was at least 388 *foot-pounds*, and any one acquainted with the subject must see that with this primitive apparatus only a small part of the power of the current could be utilised.

Mr. Slater encouraged and convinced by the result, is now engaged in the construction of a larger engine, fitted for practical work, and made in a more workmanlike and scientific manner, with numerous magnets instead of only three. Having spent a large part of his life, and hundreds, or even thousands, of pounds in experimenting on the best construction of magnets and best method

utilising electric power, he has at last attained a result which is practically most important. His practical acumen and experience always convinced him of the error of Joule's views, and proved to him that there was sufficient power resident in electro-magnets to make an economical motive power, if he could but devise a means of getting it out.—I am, &c.,

H. HIGHTON.

2, The Cedars, Putney,
Sept. 25, 1871.

VALENCY OR ATOMICITY.

To the Editor of the Chemical News.

SIR,—There is perhaps no doctrine of modern chemistry that has been more fully examined or discussed than "Valency" or "Atomicity," and yet it must be admitted that the proper rank of several important elements in the scale of equivalency is still undetermined.

If we take, for example, nitrogen, N, we find that in ammonia, H_3N, it is trivalent, although in nitric oxide, NO, it is divalent, corresponding to O, which is usually regarded as a dyad.

Then again, carbon, C, in carbonic acid, CO_2, is tetravalent, although in carbonic oxide, CO, it is divalent, assuming, as before, that O has invariably the same valency.

My chief object, however, in this brief communication, is to draw attention to iron, Fe, which is ranked, I believe, by all chemical writers as a divalent element. And if the protoxide, FeO, be taken, the Fe must certainly be viewed as divalent, provided the oxygen with which it is combined be O". But if instead of FeO, we select the sesquioxide, Fe_2O_3, we find that the Fe ought to be trivalent to correspond to O_3.

If we glance, too, at the simple chemical equation—

$$Fe_2O_3+6HCl=Fe_2Cl6+3(H_2O),$$

we find the Fe_2 taking the place of 6H, and consequently the Fe appears, as in the instance of Fe_2O_3, to be a triad rather than a dyad.

As another anomalous example, I would just refer to the bisulphide, FeS_2, for in this compound we have to regard the metal as tetravalent, if S be divalent or S".

What, then, is the true quantivalence of Fe, and how can it be definitely determined?

This important enquiry I beg to submit to your numerous scientific readers.—I am &c.,

W. H. O.

Mildmay Road, Stoke Newington,
Sept. 20, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

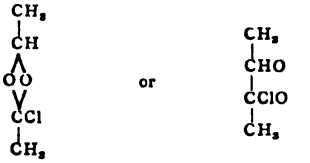
Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, August 28, 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Action of Chlorine upon Aldehyde.—A. Wurtz.—Since MM. Krämer and Pinner (*Deutsche Chem. Gesellsch. Berlin*, 1870, p. 383) had contested the accuracy of the author's experiments on the above-named subject (published in the *Annales de Chimie et de Physique*, 3rd series, vol. xlix., p. 58), the author has repeated his former experiments. As before, he has found that there is formed chloride of acetyl and a product, $C_4H_7ClO_2$, boiling at 120°, being the same as that which MAXWELL SIMPSON has found by directly combining aldehyde with chloride of acetyl; although there is no doubt whatever concerning the formation of chloride of acetyl as a product of the action of chlorine upon aldehyde—mixed, however, with perchloride of carbon, in order to lessen the violence of the reaction—there are other by-products formed, of a high boiling-point, which, excepting the compound $C_4H_7ClO_2$, have not been further studied; the constitutional formula of that compound is either—



This compound is decomposed by water, and the manner of its decomposition proves that the formula assigned to this body, by the German *savants* above-named, is not correct—viz., $CH_3ClCOH+CH_3COH$.

Essay on the Use of Divers Alloys, and more especially of Phosphorus-Bronze, for the Casting of Pieces of Ordnance and other Purposes.—Montéfiore-Lévi and Künzel.—This paper is a lengthy abstract from a work published by the authors, and containing the detailed account of an extensive series of experiments made on the large scale on the preparation of various alloys of copper and tin, and the effect produced thereon by the addition of phosphorus in small quantity. It appears, on the whole, that the addition of the element just named is of great value in producing alloys possessed of excellent properties, especially for the manufacture of bronze guns. The Academy has appointed a committee of six of its members, among them MM. Dumas and Frémy, to study this important matter, and report thereon.

Although not belonging to the subjects usually treated of in this periodical, we quote the following paper:—

Note on Geographical Researches Made in the Island of Madagascar during the Years 1865-70.—A. Grandidier.—A very important contribution to the physical geography of an island which appears to have been thoroughly surveyed by the author.

Aëronautic Journey of the Volta Air-Balloon, undertaken on December 2, 1870, for the purpose of a Scientific Mission.—J. Janssen.—This paper contains the very minutely-described account of the author's balloon journey from Paris to Briche-Blanc, Commune de Beuvron, Loire Inférieure, not far from Saint-Nazaire, whence the traveller proceeded by rail to Tours and, *viâ* Bordeaux, to Marseilles, and, farther, by steamer, to Oran, for observation of the last eclipse of the sun. It appears that during this journey several photographs of places and localities over which the balloon passed were taken with great success, so that this mode of obtaining maps of towns and country is at present being experimented on by M. Nadar.

Spectrum Exhibited by Sulphur.—G. Salet.—Notwithstanding the high scientific value of this paper, its contents, including a series of tabulated results, are not suited for abstraction.

Subchloride and Oxychlorides of Silicium.—L. Troost and P. Hautefeuille.—This very lengthy memoir treats, in the first place, on the preparation of the subchloride of silicium, by passing a rapid and continuous current of chlorine gas over silicium at a very high temperature—up to the point of rendering porcelain tubes as soft as wax, a heat at which malleable iron fuses readily,—care being taken to arrange the apparatus in such a manner as to cause the vapours to pass repeatedly over the silicium. The crude product, having been purified, yields the sesqui- or subchloride of silicium in the shape of a very mobile colourless liquid; sp. gr., at 0°=1·58; at −14°, this liquid freezes, and is then very similar to boracic acid; at 146°, the liquid boils; its vapour density at 239°=9·7; heated in contact with air, the vapour of this body inflames spontaneously. This substance is curiously enough, only stable at temperatures below 350° or above 1000°, but is dissociated very rapidly, especially at temperatures between 440° and 800°; the formula of this body is Si_4Cl_6. Protochloride of silicium is also a liquid, of which the boiling-point, density, and vapour density are difficultly ascertained, on account of its retaining oxychlorides of silicium. Of these last-named bodies, the authors have found no less than five, having all a different composition:—The first is a liquid, boiling at from 152° to 154°; formula, $Si_2O_2Cl_2$. The second, also a liquid, boils at 200°; vapour density, 15·9; formula, $Si_3O_3Cl_3$. The third, a liquid, boiling at 300°; centesimal formula, $Si_5O_6Cl_3$; formula, deducted from vapour density $=28·2$, $Si_{12}O_{10}Cl_{12}$. The fourth, an oily liquid, which becomes pasty at below 0°, and boils at 400°; formula, $Si_4O_5Cl_4$. The fifth, a solid body, not fused at 440°, soluble in the preceding bodies; formula, Si_2O_3Cl. The last portion of this memoir treats on the oxychlorides of boron, titanium, and zirconium.

On Nitro-Ethal, Nitro-Glycol, and the General Method of Converting Alcohols into Corresponding Nitric Ethers.—P. Champion.—Nitro-ethal is formed by the action of nitro-sulphuric acids upon previously-pulverised ethal gradually introduced into the acid liquid; the product is purified by dissolving it in ether, and washing this solution with water. Nitro-ethal is a liquid, soluble in ether, but hardly so in alcohol and water; at between 10° and 12°, it becomes solid and crystalline; the sp. gr. of the liquid=0·91; its formula is $C_{28}H_{88}(NO_6)$. A high temperature decomposes this substance, a carbonaceous residue being left. When put upon a piece of very hot sheet-iron, nitro-ethal takes fire, assumes at the same time the spheroidal state, and burns off with a sooty flame. Nitro-glycol is prepared by the action of nitro-sulphuric acids upon glycol in the same manner as nitro-glycerine. The former-named body is a fluid, sp. gr. =1·48, insoluble in water, very soluble in alcohol and ether, and detonating violently by percussion but not by the action of a high

temperature. Nitro-glycol is poisonous, and exhibits, when taken internally, symptoms akin to those produced by nitro-glycerine. By careful manipulation, and especially by applying lower temperatures to the acid mixture alluded to, the author has been enabled to prepare, rom a series of alcohols, nitric ethers.

Journal für Praktische Chemie, Nos. 11 and 12 (double number), 1871.

The following original papers are contained in this number:—

Contribution to our Knowledge of Hyponitric Acid and Nitrous Acid.—Dr. C. W. Hasenbach.—The leading points of this exhaustive essay, illustrated by woodcuts, may be summarised as follows:—Nylander's idea, that a peculiar and isomeric hyponitric acid is formed when arsenious acid is oxidised by the aid of nitric acid (sp. gr., 1·33), is not correct, the fact being that either a mixture of nitrous and hyponitric acids, or the latter only, is formed, this being dependent upon the degree of concentration of the nitric acid employed. Hyponitric acid and deutoxide of nitrogen combine together at a high temperature, forming chemically-pure nitric acid; hyponitric acid and chlorine yield, under similar conditions, the chloride of nitric acid; bromide of nitric acid cannot thus be obtained in pure state, since the combination is destroyed by boiling; iodine and hyponitric acid do not combine at a high temperature; cyanogen and hyponitric acid form at a high temperature a most violently-explosive compound, probably the cyanide of nitric acid; the compounds of hyponitric acid with chlorine, bromine, and cyanogen are not formed at all, or only to a very limited extent, at a lower temperature: nitrous acid and oxygen combine even at the ordinary temperature of the atmosphere, forming hyponitric acid; carbonic oxide and sulphurous acid combine at a comparatively low temperature, forming compounds which have not been further investigated; benzol is not directly nitrated by hyponitric acid unless aided by sulphuric acid, in which case nitrobenzol is formed. The author prepares hyponitric acid in large quantity by treating nitric acid (sp. gr., from 1·38 to 1·40) with small lumps of arsenious acid of the size of peas, heat being applied and a good condenser. Through the dark green coloured liquid collected in the receiver (a mixture of nitrous and hyponitric acids) a current of oxygen or atmospheric air is passed, in order to convert the nitrous acid into hyponitric acid, after which the liquid is rectified by carefully conducted distillation. The molecular formula of liquid hyponitric acid is—

$$\left\{\begin{matrix}NO_2\\NO_2\end{matrix}\right.,$$

but that of the vapour above 100° is NO_2.

On Sulphur Compounds.—Dr. E. Drechsel.—Owing to the large number and complexity of the formulæ required for the due understanding of the contents of this valuable essay, it is not well suited for abstraction.

Conversion of Formic Acid into Methylic Alcohol.—A. Lieben and A. Rossi.—From formiate of lime, formylic aldehyde was obtained by distillation; the crude product of this operation was rectified, and treated with sodium amalgam, and then again submitted to fractional distillation. The liquid resulting from that operation, being treated with caustic potassa, yielded a fluid which was by further rectification found to be identical in every respect with methylic alcohol; 250 grms. of formiate of lime yielded about 4 grms. of the alcohol.

On Monobenzyl-Urea.—S. Canizzaro.—Among the products of the reaction between benzylic chloride and cyanide of potassium, the author found, in addition to dibenzyl-urea (a solid body), also another compound, which is rather soluble in water and alcohol, but best in ether. This substance is, in the pure state, a solid crystalline body, fusing at 147°; heated to 200°, ammonia is given off, and dibenzyl-urea. The formula of the monobenzyl-urea is—

$$CO\left\{\begin{matrix}NH_2\\NH.C_7H_7\end{matrix}\right.$$

Preliminary Notice on a New Method for Forming Hydrocarbons.—F. Pfankuch.

On Sulpho- and Cyanoform.—F. Pfankuch.—By causing sulphur to act upon iodoform contained in a sealed tube, the author has obtained a compound, $C_2H_2S_2$. By experimenting with iodoform and mercuric cyanide, the author obtained a body which is to be considered as the double salt of cyanoform with iodide of mercury; formula—

$$[CH(CN)_3]_3[HgI_2]_3.$$

On Sulphur Ethyls.—M. Müller.—Preliminary notice.

Gases Occluded in Coal.—E. Meyer.—Preliminary notice; reserved for full translation.

Action of the Hydracids upon the Alkaloids of the Cinchona Group.—W. Zorn.—Preliminary notice.

Products Obtained by the Electrolysis of Acetate of Potassa.—Drs. T. Kempf and H. Kolbe.—Twenty-two years ago, Dr. Kolbe proved that the chief products of the electrolysis of a concentrated solution of acetate of potassa were carbonic acid and methyl-gas; resuming these experiments, the authors now find that, by the process alluded to, also ethylen, acetate, formiate, and carbonate of methyl are formed, and a substance which as yet has not been further investigated.

Action of Ethylen Iodide upon Acetylide of Copper.—E. Carstanjen and A. Schertel.—Prelimary notice; a remark which also applies to the following, as well as to some of the foregoing, papers, all of which are published only in a fragmentary form, the researches they communicate being temporarily discontinued on account of the holidays.

Experiments Made with the View to Prepare a Carbonic Oxide Cyanide, $CO(CN)_2$.—E. Carstanjen and A. Schertel.

Oxidation of the α Naphtyl-Carbonic Acid, $C_{10}H_7.COOH$.—E. Carstanjen and A. Schertel.

Synthesis by Nascent Formic Acid.—E. Carstanjen and A. Schertel.

On Chloraceton and Cyanaceton.—L. Glutz and E. Fischer.

On Simple Chlorinated Chlorethyl.—W. Wolters.

On some Chromium Compounds.—J. Heintze.

Action of Potassium Sulphydrate upon Chlorbenzoyl.—A. Weddige.

New Derivatives from Chloride of Carbon.—K. Hoch and H. Kolbe.

Decomposition of Grape Sugar by Oxide of Copper in Alkaline Solution.—A. Claus.—We regret that the length of this highly valuable monograph prevents any other quotation than the title.

Zeitschrift für Chemie von Beilstein, No. 9, 1871.

This number contains the following original papers and memoirs:—

Contribution to our Knowledge on the Quintanes (Quintane).—M. Lwow.—This paper records some experiments made with the view of obtaining by synthesis a normal quintane—

$$CH_3—CH_2—CH_2—CH_2—CH_3.$$

Normal iodbutyl and zinc methyl were found not to react upon each other even at a high temperature, but the tertiary iodbutyl, $C(CH_3)_3I$, acts upon zinc methyl at the ordinary temperature; the main result of this reaction was found to be a fluid lighter than water, and of a high boiling-point (polybutylen). The result of the reaction of iodmethylen and zinc ethyl was—$2Zn(C_2H_5)_2+2CH_2I_2=2(C_2H_5)_2+C_2H_4+2ZnI_2$.

Preparation of Methylen Iodide.—J. Bljuducho.—This paper treats on the most advantageous method, and the best proportions, of preparing methylen iodide by the reaction of HI upon chloroform. The result obtained is that the best proportion corresponds to the formula $CHCl_3+4HI$—5 grms. of chloroform to 40 grms. of hydriodic acid, the mixture being heated for twenty-four hours to 130° in a sealed tube.

Miscellaneous Researches.—A. Engelhardt and P. Latschinow.—This lengthy essay is divided into the following sections:—Diphenyl bodies; preparation of diphenyl; diphenyl-sulpho-acid; diphenyl-disulpho-acid; bromated α thymol-sulpho-acid; binitro-thymol from α thymol-sulpho-acid; oxidation of thymol; bromated para-cressol-sulpho-acid; chrysanissic acid; binitro-phthalic acid.

Structure of Chlor-Iod-Propylen.—W. Sorokin.—This paper is not suited for useful abstraction, as it requires a large number of complex formulæ; an observation which also applies to the two following papers:—

Structure of Ethylen.—W. Kriwaxin.

So-Called Dichloraceton.—W. Kriwaxin.

Decomposition of Ethylen Bromide by Water.—W. Kriwaxin.—This paper contains the results of some experiments made with the view to prove that Carius's experiments (*Ann. Chem. Pharm.*, cxxx., 172), according to which $C_2H_4Br_2$ and H_2O yield, at from 150° to 160°, aldehyde and HBr, are wrong, since the substance taken by him for aldehyde-ammonia is only bromide of ammonium.

Hydrocarbon, C_7H_{14}, and its Derivatives.—W. Markownikow.—The hydrocarbon alluded to has at 14° a sp. gr. of 0·6985; vapour density, 3·387; colourless, very mobile fluid. Pseudo-heptylen (C_7H_{14}) combines readily with iodine and bromine, but the bromide ($C_7H_{14}.HBr$) is decomposed by water at 100°, yielding some pseudo-heptyl-alcohol, a fluid which exhibits a camphor-like smell, is not solidified at −20°, and by many of its reactions is split up into C_7H_{14} and H_2O.

Preliminary Communication on the Products of Oxidation of Dichlorhydrine.—W. Markownikow.—By treating a pure dichlorhydrine, boiling at a fixed temperature, with an oxidising mixture ($K_2Cr_2O_7$ and H_2SO_4), the author obtained a substance which formed with bisulphite of soda a solid crystalline compound—

$$C_3H_6Cl_2O.SO_3HNa.$$

Dichloraceton has been consequently formed, and the formula of dichlorhydrin is, therefore, $CH_2Cl—CH(OH)—CH_2Cl$.

On some of the Derivatives of Ortho-Toluidine.—E. Wroblevsky.—This essay contains the following sections:—Tribrom-ortho-toluidine; tribrom-toluol; dibrom-aceto-ortho-toluidine; dibrom-toluidine; dibrom-toluol; nitro-dibrom-toluol.

Properties of Trimethyl-Carbinol.—A. Butlerow.—Perfectly anhydrous trimethyl-carbinol is a solid body, rhombo-prismatic crystalline, fuses at 25°, attracts water and dissolves therein, boils at 82·5°; sp. gr., at 30°=0·7788, at 0°=0·8075. Trimethyl-carbinol hydrate, $2C_4H_{10}O+H_2O$, is fluid at 0°, boils at 80°; sp. gr., at 0°=0·827.

Triethyl-Carbinol.—A. Nahapetian.—The substance just named, prepared from propionic acid chloride and zinc ethyl, is fluid even at −20°, has a camphor-like smell, and is almost insoluble in water; sp. gr., at 0°=0·8593.

Dimethyl-Pseudo-Propyl-Carbinol.—J. Prianichnikow.—The body just mentioned is a fluid boiling at 112° to 113°, soluble in water, freezes at −35°; sp. gr., at 0°=0·8364; by oxidation, it yields aceton and some acetic acid.

On a New Amylen.—M. Ermolaien.—The iodide of dimethyl-ethyl-carbinol yields, when decomposed with alcoholic solution of caustic potassa, the amylen here alluded to, according to the following formula, the reaction requiring no heat and separation of a fluid:—

$$C_5H_{10}=\overset{II}{C}(CH.CH_3).\overset{I}{C}H_2.\overset{I}{C}H_3, \text{ or } \overset{II}{C}.CH_2.\overset{I}{C}H_2(CH_2.\overset{I}{C}H_3).$$

The amylen combines with bromine.

Platin Cyanide and Tartrates of Glucinum.—F. Toczynski.—This exhaustive memoir is divided into the following sections:—On glucina and its reactions; cyanogen compounds of glucinum; tartrates of glucinum.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, June, 1871.

This number contains no original papers relating to chemistry or allied sciences.

Les Mondes, August 31, 1871.

Among the original matter contained in this number we notice the following:—

Sand and Clay.—Dr. Choyer.—A lengthy but interesting geological essay.

Conduction of Heat.—Rev. Laborde.—This paper treats on some phenomena observed by the author while directing a blowpipe flame on the surface, as well as on jets, of water; and on some practically useful conclusions to be deduced from his experiments.

Pressure Exerted by the Gases Generated by the Explosion of Gunpowder.—Captain Noble.—A very important essay on this subject; also containing a good account of the various labours of different authors who, since De la Hire (1702) first sought to explain the action of gunpowder, have treated on this subject up to the present day.

American Journal of Pharmacy, September, 1871.

The original papers contained in this number only bear upon subjects specially relating to pharmacy and pharmacognosy.

La Revue des Scientifique de la France et de l'Etranger, September 9, 1871.

This number does not contain any original papers relating to chemistry or allied sciences.

NOTES AND QUERIES.

Soda from Cryolite.—(Reply to W. F. Catcheside.")—The process is very completely and accurately described, and if you work carefully you will certainly be able to obtain the results precisely as stated; supposing any cryolite to be imported, it is more likely to find its way to either Liverpool, Glasgow, or Newcastle-upon-Tyne than to London.

Test for Nitric Acid.—(Reply to "Chemicus.")—Take a freshly-made cold saturated solution of pure sulphate of iron in distilled water, and pour some of this solution into a test-glass, and add slowly an equal bulk of the sulphuric acid to be tested for nitrous compounds, taking care to let the acid flow slowly and gradually along the side of the glass into the sulphate of iron solution. After having been left standing for some time (a few hours at least) there ought not to appear between the two layers of the fluids a brownish coloured film; if such appears, the sulphuric acid is contaminated with nitrous compounds. Sulphate of aniline—made *extempore* by adding five drops of aniline to 25 c.c. of pure dilute sulphuric acid (sp. gr. = 1·113 to 1·117 = = 13 per cent strong acid), and stirring the two liquids until the solution is complete—is cautiously added in a quantity of ½ c.c. to 1 c.c. of the sulphuric acid to be tested; if the latter contains even a slight trace of nitric acid, a rose red-coloured layer will make its appearance between the fluids

TO CORRESPONDENTS.

M. P. S.—Gesner's work on "Coal-Tar Products" will probably answer your purpose.

R.—Consult Watts's "Dictionary of Chemistry."

T. W.—This correspondent wishes to know—(1) Extent and price of Dr. Gladstone's lecture on "Theology and Natural Science." (2) Where Dr. Moffat's lecture on "Alum in Bread" is published. (3) If Dr. Frankland's "Lecture Notes" vol. ii. (Organic Chemistry), is published yet.

A. Keiffenheim and Co.—We will supply the information next week.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 619.

ON THE EXISTENCE OF SULPHUR DICHLORIDE.*

By JOHN DALZIEL and T. E. THORPE.

WHEN dry chlorine in excess is passed through molten sulphur, a dark red fuming liquid slowly distils over. This on renewed distillation commences to boil at about 50° or 60°, and the thermometer slowly rises to 136° or 137°, at which point it remains stationary, and orange-yellow disulphide, Cl_2S_2, passes over. The fraction boiling below 136° frequently amounts to three-fourths of the original quantity of liquid; on again submitting it to distillation, the same order of things is repeated, and but a comparatively small portion distils over 136°. At each distillation the liquid becomes lighter in colour, until at length, by long-continued boiling, it assumes the bright yellow tint of the disulphide, and boils constantly at 136° to 137°. This behaviour would seem to indicate the existence of some compound of chlorine and sulphur which slowly undergoes decomposition on distillation, ultimately forming the disulphide, and the observations of Dumas and Soubeiran, and of Marchand, Davy, and Rose, point to a body richer in chlorine than the disulphide, and their analyses lead to the formula SCl_2. On the other hand, Carius denies the existence of sulphur dichloride in the dark red liquid obtained by heating sulphur in chlorine, and asserts that the compound analysed by Dumas and others was a mixture in atomic proportions of the disulphide with a tetrachloride of sulphur hitherto unisolated, $Cl_2S_2 + SCl_4 = 3Cl_2S$. According to Carius, the amount of chlorine contained in the liquid over and above that required by the formula S_2Cl_2 is altogether dependent on the temperature; but the fact of the protracted distillation required to break up the product into a liquid boiling constantly at 136° to 137° implies, however, that the excess of chlorine is held by some other force than that of mere solution; at the same time we are not altogether without facts more directly indicating the existence of the dichloride. Rose has obtained a compound of this body with the terchloride of arsenic, $2AsCl_3Cl_2S$, and according to Guthrie it yields with the olefines compounds of the general formula $C_nH_{2n}Cl_2S$. Hübner and Gueront† have lately made an observation, which also tends to support the idea of the existence of this body. A quantity of the pure chloride, S_2Cl_2, was placed in a strong freezing mixture, and a current of dry chlorine passed through it for some time, the excess of this gas (that is, that existing merely in solution) being displaced by a stream of dry carbon-dioxide passed through for three or four hours. Whilst still in the freezing mixture a small quantity of the chloride was withdrawn and analysed, when numbers were obtained exactly agreeing with those required by the formula Cl_2S.

We have repeated this experiment with precisely the same result. A quantity of pure S_2Cl_2 was first prepared; it boiled constantly at 136° to 137°, and was analysed with following results:—

	Calculated.		Found. I.	Found. II.
S_2	64 ..	47·42	— ..	—
Cl_2	71 ..	52·58	52·48 ..	52·67
	135	100·00		

About 20 grms. of this liquid were then saturated with chlorine in the manner described by Hübner and Gueront; after the excess of chlorine had been removed by carbon dioxide, it yielded the following numbers on analysis:—

	Calculated.		Found. I.	Found. II.	Dumas.	H. & G.
S	32	31·07	—	—	31·9	30·5
Cl_2 ..	71	68·93	69·25	69·06	68·1	69·3
	103	100·00			100·0	99·8

The existence of this body would therefore appear to be fully proven, for it is scarcely possible that such an agreement can be the result of an accidental coincidence.

From these experiments, therefore, we draw the same conclusions as those deduced by Hübner and Gueront, viz.—that there exist two compounds of chlorine and sulphur analogous to the oxides of hydrogen. First, a non-volatile chloride, having the formula SCl_2, corresponding to H_2O, which on distillation splits up into chlorine; and the second, chloride, S_2Cl_2, corresponding to peroxide of hydrogen, $2Cl_2S = S_2Cl_2 + Cl_2$.

It will be at once apparent that in one respect the analogy between these chlorides and the oxides of hydrogen is incomplete, in so far that the most stable oxide of hydrogen, is water, into which the dioxide is easily converted by heating, whereas the reverse of this happens with the corresponding sulphur chlorides, the most stable compound being the S_2Cl_2, into which body and free chlorine the SCl_2 is resolved on heating.

ON THE COMPOSITION OF THE GASES EVOLVED FROM THE BESSEMER CONVERTER DURING THE BLOW.

By GEORGE J. SNELUS,
Associate of the Royal School of Mines.

1. *Design of the Investigation.*

THE members of the Iron and Steel Institute will remember that Professor Roscoe, in his lecture on Spectrum Analysis, alluded to the difficulty of determining the cause of the greater part of the lines in the Bessemer spectrum, and pointed out, that while the majority of observers referred them to carbon in some form, there were others who believed them to be mainly due to manganese. Assuming the lines to be due to carbon, it is clear that an analysis of the gas producing the lines would be a step towards solving the difficulty, since it would show us which condition of carbon we must refer them to. This is important because we know that carbon in different gaseous combinations and at different temperatures produce, as Dr. Watts has pointed out, several distinct spectra.

Another question which suggests itself on examining the spectrum is, that supposing the characteristic lines are due to carbon, "How is it that the spectrum of carbon is not seen in the earlier stages of the blow, when an analysis of the metal proves incontestibly that carbon is being burnt in considerable quantities from the commencement?"

It appeared to me that analyses of the gas at different stages of the blow might help to a solution of these problems, for though it is generally assumed that during the process of conversion the carbon of the pig is burnt to carbonic oxide, this, as far as I am aware, has never been *proved* to be the case. It will be seen from the analyses, that this turns out to be only partially true, and that the composition of the gases evolved affords us an insight into the nature of the process going on that could not be supplied by analysis of the metal and slag at successive stages.

* Read before the British Association, Edinburgh Meeting, Section B.

† *Zeitschrift für Chemie*, xv., 1870, 455.

2. Method of Collecting the Gas.

The gas for analysis was collected by means of a long iron gas-pipe, on the end of which a swan-neck trumpet mouth-piece of fire-clay was fixed, which was inserted in the neck of the converter, after it had been turned up. This generally got clogged up with slag during the experiment, and therefore served only for one trial. It was allowed to dip into the vessel, so as to be certain that no air could be drawn into the tube by induction. To the other end of the pipe glass tubes were attached at particular periods of the blow when the gas was required, and sealed up with the blow-pipe before being removed. A constant stream of gas was allowed to rush through the tube the whole time, and as this was done for two minutes before the first sample of gas was collected, it may be safely assumed that the whole of the air was swept out, and that the gas analysed was a true sample of that produced by the direct action of the blast upon the metal and its constituents.

It was found that during the first part of the blow, the gas would not light at the end of the iron tube, but that from about the commencement of the boil to the end of the blow, it burnt with the pale blue flame characteristic of carbonic oxide.

Samples were taken every two minutes and subjected to analysis with the subjoined results.

3. Methods of Analysis Employed.

The gases were analysed in a modified form of the apparatus, described by Professor Frankland, for analysing the gases incident to water analysis, which was found extremely convenient. Samples 3 and 5 were analysed by different methods, the carbonic oxide in one case being estimated by absorption with a hydrochloric solution of subchloride of copper, and in the other by explosion with detonating gas and oxygen, and subsequent absorption by potash, after the method of Bunsen. It will be seen that the results agree closely.

4. Details of the Analyses of Gas, with Deductions therefrom.

Sample 1.—This was taken two minutes from the start of a blow which lasted 18 minutes. It contained:—

Carbonic acid	10·71
Oxygen	0·92
Carbonic oxide	none
Hydrogen (not estimated) and Nitrogen	88·37
	100·00

This I considered to be an unlooked for result, because it is usually assumed that the carbon is burnt directly to carbonic oxide at all stages of the blow. Taking the nitrogen in this sample at 87 per cent, this corresponds to 23·05 vols. of oxygen. 10·71 vols. carbonic acid contain 5·35 vols. carbon vapour, which, referred to air as unity, represent 4·43 parts by weight of carbon. The carbonic acid contains its own volume of oxygen, which deducted from 23·05 leaves 12·34 vols. = 13·62 parts by weight of oxygen to combine with other elements than carbon. Now, ordinary English Bessemer iron contains little else for oxidation than carbon, silicon, and iron; the manganese being usually small in quantity, traces only of the sulphur disappearing, and the phosphorus remaining untouched. Of the three oxidisable elements, it is known from analysis of the slag that the iron is not burnt to any extent till towards the end of the blow, so that we have only to consider the carbon and silicon.

The 13·62 parts of oxygen may, therefore, be assumed to be combining with silicon alone, so that as 32 parts of oxygen unite with 28 silicon, or in the ratio of 8 to 7, we have 11·91 parts silicon being oxidised at this stage, along with 4·43 parts of carbon; thus showing that, though both elements are being oxidised, it is the silicon which is disappearing most quickly. Now this is exactly what analysis of the metal proves, for a charge containing, on running into the converter—

3·57 per cent carbon
2·26 per cent silicon

was found by Mr. Barker in a few minutes to have lost—

0·53 per cent carbon and
1·305 per cent silicon.

As an example of the nature of the gas evolved at a point between the times when this first sample was taken and that obtained two minutes later, I give here analyses made by my friend, W. Thorp, F.C.S., of the Rivers' Commission Laboratory, of two consecutive tubes of gas which I collected four minutes from the commencement of a blow, which, from the converter being new, or the iron cold, lasted 29 minutes:—

	No. 1 tube contained.	No. 2 tube contained.
Carbonic acid	8·940	9·296
Oxygen	0·916	0·113
Carbonic oxide	0·078	0·044
Hydrogen and Nitrogen	90·066	90·544
	100·000	100·000

Sample 2.—Taken four minutes from commencement; contained:—

Carbonic acid	8·57
Carbonic oxide	3·95
Hydrogen	0·88
Nitrogen	86·58
	100·00

It will be noticed that carbonic oxide is gradually increasing, while carbonic acid is decreasing in quantity.

Sample 3.—Taken six minutes from start; contained—

	By absorption.	By explosion.
Carbonic acid	7·89	8·20
Carbonic oxide	4·65	4·52
Oxygen	absent	absent
Hydrogen	—	2·00
Nitrogen	87·55	85·28
	100·00	100·00

Dissecting these results after the manner of those for No. 1, we find that 85·28 nitrogen correspond to 22·61 vols. oxygen. The carbon is combined with 10·46 vols., leaving 12·15 vols. (13·42 parts by weight) of oxygen, to combine with other elements. This will require 11·74 parts silicon, while the carbon going off as gas amounts to 5·27 parts. Carbon is, therefore, now being oxidised more rapidly in proportion to the silicon than was the case when No 1 sample was taken.

Sample 4.—This was taken ten minutes from the start, and as soon as possible after the boil had commenced. The complete spectrum was now visible and constant, and remained so to the end of the blow. The gas contained:—

Carbonic acid	3·58
Oxygen	none
Carbonic oxide	19·59
Hydrogen (not estimated)	2·00 (probably)
Nitrogen	74·83
	100·00

The great increase in the proportion of carbonic oxide, and corresponding decrease of carbonic acid, will here be noticed. This accounts for the increased luminosity of the flame at this period, as we have now a large volume of gas actually burning at the mouth of the converter. Assuming all the oxygen now being evolved in combination to be derived directly from the blast at present

passing through the iron, we have for the 74·83 vols. nitrogen 19·84 vols. oxygen entering the converter, but the carbonic acid contains 3·58 vols., and the carbonic oxide 9·79 vols., together 13·39 vols., in combination with carbon, leaving 6·47 vols. for other work. This would oxidise 6·25 parts silicon, and there are now 9·6 parts of carbon being burnt, so that the conditions are now reversed, carbon being oxidised at a more rapid rate than silicon. This is the point at which the carbon lines become well defined, and the analyses, we think, shows why this is so.

Sample 5.—Taken 12 minutes from start; gave—

	By absorption.	By explosion.
Carbonic acid	2·47	2·30
Oxygen	absent	—
Hydrocarbons	absent	—
Carbonic oxide	29·58	29·30
Hydrogen	—	2·16
Nitrogen	67·95	66·24
	100·00	100·00

This sample of gas was specially tested for hydrocarbons, as being the most likely period of the blow to detect them if they were formed to any extent. But although the gas was left in contact with fuming sulphuric acid for 12 hours, no absorption took place. As the results by explosion agree in showing the absence of these gases, I think we may fairly conclude that none are formed.

Sample 6 was taken 14 minutes from start, and four minutes from end of blow. It gave—

Carbonic acid	1·34
Oxygen	absent
Carbonic oxide	31·11
Hydrogen (not estimated)	2·00 (probably)
Nitrogen	65·55
	100·00

The large percentage of carbonic oxide, and almost absence of carbonic acid, is remarkable, 65·55 parts nitrogen correspond to 17·37 oxygen, 16·89 vols. (18·66 parts by weight) are combined with 13·45 parts of carbon, leaving 0·53 parts of oxygen which would combine with 0·46 parts silicon; so that at this point it is practically carbon alone that is being oxidised, the last traces of silicon disappearing very gradually.

Looking through these analyses, we note the broad fact, that carbonic acid is formed in the first part of the blow with little or no carbonic oxide, while during the latter part, carbonic oxide is formed with only traces of carbonic acid. The question "Why is this?" suggests itself: why should the carbon take up twice as much oxygen at one time as another, under apparently the same conditions? My own impression is, that both this chemical reaction, and also the difference between this carbon spectrum and that from carbonic oxide, under ordinary circumstances, are functions of temperature. It is certain that at the commencement of the blow the temperature cannot be much above a yellow heat, while at the end of the blow it is undoubtedly a good white heat; now, it appears to me, that under the conditions in the converter, carbonic oxide is the most stable body at a high temperature, and carbonic acid at a lower one. This agrees with the experiment of our V.-P., I. Lowthian Bell, where he shows that the conditions of equilibrium for these gases in the presence of metallic iron are—

Low red heat	150 vols. carbonic acid	for each 100 carbonic oxide.
Full red "	47 " "	
Approaching whiteness	11 " "	

It also agrees with the general observation, that if the iron is cold when it comes from the melting furnace, the period of the boil is delayed, while if the iron has been kept in a reverberatory melting furnace for a considerable time at a high temperature, this period is reached more quickly. The action of the oxygen upon the silicon may have something to do with the degree of oxidation of the carbon, for I find that the time when the boil takes place depends closely upon the quantity of silicon contained in the iron. Thus, with pig containing about 2½ per cent silicon, the boil takes place about the middle of the blow, while with Swedish iron, which contains only about 1 per cent silicon, this point is, I believe, reached much sooner.

Alterations of temperature produce changes in spectra, and I think it will be found that this Bessemer spectrum, or at least that part of it which is due to carbon, is simply the spectrum at which it is burning at the mouth of the vessel.

5. *Comparison of the Gas with Spectroscopic Appearances.*

	Spectrum observations show—	Analysis of the gas shows—
1st Stage—		
0 to 4′.	Faint continuous spectrum. No actual flame.	Carbonic acid evolved but little orno carbonic oxide.
4 to 8′.	Sodium, potassium, and lithium lines appear. Towards the close occasional flashes of carbon lines.	Carbonic acid still given off with but little carbonic oxide. The temperature, certainly rising and causing the volatilisation of alkaline metals.
2nd Stage—		
8 to 10′.	Dense flame. Bright carbon lines in red, blue, and green fields.	Carbonic oxide evolved in quantity and burning at a high temperature at the mouth of the converter.
10 to 14′.	Bright green carbon lines more distinct.	Carbonic oxide much increased in quantity.
14 to end.	Carbon lines bright till close, when they suddenly disappear.	Carbonic oxide still being evolved up to end of reaction.

6. *Luminosity of the Flame.*

It has been suggested by Mr. M. Williams (see *Nature*) that the great brightness of the flame might be due to hydrocarbons, but analysis shows that this supposition is untenable. I think it more likely that the reason why we get such a bright flame from carbonic oxide during the blow is, that it is burning at the mouth of the converter at a much higher temperature than we get when we ignite a jet of the cold gas; for it is evident that the carbonic oxide formed in the metal-bath must have even a higher temperature than the metal itself, and this is superadded to the temperature developed by carbonic oxide burning in air. This is in accordance with the explanation given by H. Ste.-Claire Deville and Kirchhoff of the increase of luminosity of flames when burnt under great pressure, viz., that the temperature of the flame is thereby increased.

7. *Comparison of Converter Gas with Blast-furnace Gas, and with Gas from Siemens's Producer.*

It may be interesting to compare the composition of the gas during the latter part of the blow with other available gases met with in an iron works. I have selected as blast-furnace gases a sample of gas from a Cleveland furnace, by I. L. Bell, Esq., and one from a Bessemer furnace, by Wm. Crossley, Esq., and have added two samples of gas from Siemens's producers at Dowlais, which I have recently had occasion to analyse.

	Siemens's producer gas. I.	Siemens's producer gas. II.	Bessemer converter. Mean composition of gas during last half of the blow.	Cleveland B. Fce. gas.	Askam Fce. on Bessemer pig.
Carbonic acid	4·3	5·2	1·34	17·30	8·36
Carbonic oxide	25·6	24·4	31·11	25·20	34·97
Hydrocarbons	2·8	trace	—	—	—
Marsh gas	1·6	2·4	—	—	—
Hydrogen	—	8·6	2·00	0·10	2·16
Nitrogen, &c.,	65·7	59·4	65·55	57·40	54·51
	100·0	100·0	100·00	100·00	100·00

8. *Value of the Gas as Fuel.*

It will be seen from these analyses that the gas from the Bessemer converter during the last half of the blow is really of as much value as any gas made purposely, or incidentally, at an iron works. This is a most important fact, and if we consider the amount of fuel thus going to waste the question naturally suggests itself whether it cannot be made available.

If we assume that during the latter half of the blow two-thirds of the total carbon in the pig is burnt, and take the melted iron to contain 3½ per cent carbon, we find that a Bessemer works, using only 1000 tons of such pig per week, is wasting a quantity of fuel equal to 23½ tons pure carbon, or say 25 tons coke.

9. *How the Gas could be made available.*

Now, I would suggest that it is possible, by simple mechanism, to collect this gas and pass it under boilers, when it would save its equivalent of coal. The large body of flame is not wanted for any purpose. True, the workman now depends upon its indications to afford him the means of judging when the blow is completed, but the spectroscope would do this with greater accuracy with a fraction of the gas which now roars from the converter.

The nature of the gases evolved during the blow will, of course, vary with the quality of the iron used, but as it is not possible to use iron with much less than 3 per cent carbon, the quantity of carbonic oxide evolved cannot be much less than that found in the foregoing analyses, and I believe that whatever may be the nature of the iron, the general results will be the same. It would be interesting to have a similar series of analyses of gases from highly manganiferous pig for comparison, and I trust that other workers in this interesting metallurgical department will supply the deficiencies which my own analyses leave.

Dowlais Laboratory,
August, 1871.

Comparison of Amounts of Silicon and Carbon Oxidised.

No. 1	Silicon	72·91	100·00
	Carbon	27·09	
No. 2	Silicon	69·80	100·00
	Carbon	30·20	
No. 3	Silicon	69·01	100·00
	Carbon	30·99	
No. 4	Silicon	39·58	100·00
	Carbon	60·42	
No. 5	Silicon	4·24	100·00
	Carbon	95·76	
No. 6	Silicon	3·34	100·00
	Carbon	96·66	

Comparison of Amounts of Carbon Oxidised to CO *and* CO_2.

No. 1	C to CO	0	100·00
	C to CO_2	100	
No. 2	C to CO	31·52	100·00
	C to CO_2	68·48	
No. 3	C to CO	35·54	100·00
	C to CO_2	64·46	
No. 4	C to CO	84·54	100·00
	C to CO_2	15·46	
No. 5	C to CO	92·72	100·00
	C to CO_2	7·28	
No. 6	C to CO	95·87	100·00
	C to CO_2	4·13	

Tabulated Statement showing Composition of Gases and Spectroscopic Observations during the Blow.

	No. 1. 2 minutes from start.	No 2. 4 minutes.	No. 3. 6 minutes.	No. 4. 10 minutes.	No 5. 12 minutes.	No. 6. 14 minutes.
Carbonic acid ..	10·71	8·57	8·20	3·58	2·30	1·34
Oxygen	0·92	—	absent	none	none	none
Carbonic oxide ..	none	3·95	4·52	19·59	29·30	31·11
Hydrogen	88·37	0·88	2·00	2·00 prob.	2·16	2·00 prob.
Nitrogen		86·58	85·28	74·83	66·24	65·55
Hydrocarbons ..	—	—	—	—	absent	—
	100·00	100·00	100·00	100·00	100·00	100·00
Observations:						
With spectroscope.	Faint continuous spectrum.	Sodium line just appearing, but in flashes.	Sodium, potassium, and lithium lines.	Full spectrum, including the carbon lines.	Full spectrum.	Full spectrum.
With naked eye.	No actual flame, abundance of sparks thrown out.	Abundance of sparks.	Quantity of sparks decreasing.	Flame dense and bright; very few sparks.	Dense flame; still fewer sparks.	Dense flame; scarcely any sparks.

PREPARATION OF HYDROSULPHURIC ACID.

By JOHN GALLETLY.

In making some experiments on the action of sulphur on paraffin, I have found that a mixture of these substances, either in equal parts or with a larger proportion of sulphur, when heated in a flask not greatly above the melting-point of the sulphur, begins to evolve hydrosulphuric acid, and continues to give off this gas steadily, while kept moderately heated, for a considerable time.

I have used this process repeatedly, and consider it the most convenient for laboratory use. With a round flask holding about a pound of the materials fitted with a tube bent at right angles about ¼-inch bore and 12 to 18 inches long, containing a little loose cotton wool, and having a smaller tube fitted to the end of this for dipping into the liquid through which it is desired to pass the gas, a convenient stream can be obtained lasting several days. The production of the gas can be stopped and renewed at pleasure by withdrawing or applying the heat. An Argand lamp should be employed, or if a Bunsen is used, the top

piece should be on the tube for spreading the flame, so as to avoid heating the flask on one spot. Heavy paraffin oil used for lubricating machinery can be substituted for the solid paraffin, and good results are also obtained with commercial stearic acid, but with the latter the tube conveying the gas soon becomes covered with drops of a milky liquid, which is probably water and finely divided sulphur. With paraffin the tubes remain clear and bright, except for a little sulphur sublimate close to the neck of the flask.

I observe that Reinsch recommends a laboratory process for obtaining pure sulphydric acid by heating in a glass flask equal parts of sulphur and suet. The recommendation does not seem to have been generally followed, but the advantages resulting from the substitution of paraffin for suet may lead to the more usual adoption of this process.

Addiewell Chemical Works.
Sept. 4, 1871.

ON A NATIVE SULPHIDE OF ANTIMONY FROM NEW ZEALAND.*

By M. M. PATTISON MUIR, F.C.S.
Student in the Laboratory of the Andersonian University, Glasgow.

IN the gold mines at the Thames, New Zealand, there are found tolerably large quantities of grey antimony ore, or stibnite, associated with the quartz and other rocks of the older series, from which gold is extracted.

The analysis of a sample of this stibnite, which I obtained about a year ago, I have now the honour to lay before the Association.

The sample had the appearance of a large mass of steel grey crystals, radiating chiefly from a central point; some of the crystals being fully an inch in length, and generally very perfectly formed. The crystals were prisms belonging to the trimetric system, soft, and easily cut with the knife in the direction parallel to the principal axis, showing, when cut, a brilliant metallic lustre.

Adhering to the crystals was a small amount of gangue, composed seemingly of siliceous matter.

For the purpose of analysis a large crystal was broken off perfectly free from any foreign matter. The specific gravity of the crystals = 4·625. The following are the results of the analysis:—

Antimony	71·09
Iron	0·24
Arsenic	traces
Sulphur	28·47
	99·80

ON THE CAUSES OF THE PHENOMENA OBSERVED WHEN THE BESSEMER FLAME IS VIEWED THROUGH COLOURED GLASSES.

By J. SPEAR PARKER,
Chemist to the Cyclops Steel and Iron Works, Sheffield.

IN a former communication (CHEMICAL NEWS, vol. xxiii, p. 25), I described the appearances seen when the Bessemer flame was observed through a combination of a blue and a deep amber or orange glass. I should not be surprised if others have failed in obtaining such well marked alterations in the colour of the flame as I there mentioned, for a very small variation in the depth of colour of the glass used is sufficient to mar the effect. Out of two dozen glasses obtained ostensibly of the same colour, I was only able to select four or five which gave the required result. If either the blue or the orange be too deep, the flame has a reddish appearance throughout, only showing different shades of red and crimson; if, on the other hand, the colour be not deep enough, the flame at the beginning and end of the process is more of a light orange than crimson, and during the period in which the carbon spectrum is exhibited appears of a much greener colour. The combination may be a little varied, however, without any great detriment if a little deeper blue be compounded with a somewhat lighter orange or *vice versa*.

I anticipated that the changes in colour of the flame when viewed through these glasses were owing to the nature of the spectrum given by the flame, and an examination of the absorption exercised by these glasses has confirmed my conjecture.

As before, the spectroscope I used was a direct vision instrument with five prisms; on placing the blue glass before the slit and viewing direct sunlight, a spectrum was obtained containing well-defined dark bands. The least refrangible portion of the spectrum from A to a little beyond B was transmitted apparently without any diminution of brightness, then a very intense black band appears extending beyond C; another dark band occurs with the line D in the centre, and between these two partial absorption takes place, only a faint reddish light being visible; on the termination of the band beyond D, a clear bright space occurs in the yellowish green, and again a broad absorption-band, not so dark as those previously mentioned, extends beyond the lines E and *b*, the blue and more refrangible portion being freely transmitted. If a double thickness of glass be interposed, the space from near B to beyond D appears as one broad dark band, while the light admitted in the yellowish green has been more rapidly absorbed than that in the red.

With one thickness of orange glass, the red, orange, and yellow are freely transmitted, but the more refrangible rays are absorbed with gradually increasing intensity till light is scarcely visible beyond F. With two thicknesses, though the red is little affected, even the yellow seems scarcely so bright by comparison, and all is darkness beyond E.

With the combination of one blue and one amber used for observing the Bessemer flame, the bright red band is seen as through blue glass, then the first dark band, again faint reddish light, the second dark band, the bright yellowish green space, again a broad absorption-band, while the blue and violet are dimly visible. Without further experiment this explains why increased depth of *either* colour should render the flame as seen through the combination redder, for both glasses absorb the green and blue more rapidly than the red rays; hence, if these were first balanced, increased depth would cause the red to predominate. An examination of the Bessemer flame by means of the spectroscope, with a blue glass interposed, shows the cause of the curious alterations in the colour, and why they agree with the indications of that instrument. When the carbon spectrum was fully developed, I found that the most prominent and brilliant group of lines occurring in that spectrum—the first in the green—fell in the centre of the second bright space. The potassium line is visible in the extreme red, but the lithium line, on the contrary, falls in the first dark band and is invisible; the first red group in the carbon spectrum is almost obliterated, and there is but a faint indication of the sodium line, then appears the bright space with the triple group in the centre, the remaining green lines, &c., being again obscured.

Hence when the flame is first observed the red light predominates, the flame appears crimson. As soon as the carbon lines flash through the spectrum, yellow flashes are seen through the glasses, and shortly the flame pre-

* Read before the British Association, Edinburgh Meeting, Section B.

sents the appearance of a light gamboge-yellow, a rose-coloured cone in the centre, and crimson edges. The production of this yellow, I think, is an additional illustration of the compound nature of that colour, for the red which previously predominated has added to it additional green light (in consequence of the appearance of the group of bright lines) and the result is yellow. However, it might be explained on the old principle, that the green being of a yellowish tint, the red and true green neutralise, the excess of yellow predominating. The central rose-coloured cone corresponds to the hollow of a Bunsen's flame, where no combustion can occur, and consequently the characteristic spectrum is not produced. With regard to the crimson edges, it is possible that here the carbon lines are not developed, complete combustion having occurred. In the "spiegel flame," as I before remarked, the green groups are brighter and more prominent than in the ordinary spectrum, and this gives a greenish yellow hue when seen through the glasses. I think the slightly different appearances observed by Mr. Rowan, and Professor Silliman, are easily explained. Mr. Rowan used two blue glasses, which though doubtless of a lighter tint than the one I employ, together caused the red to predominate throughout, as previously explained. Professor Silliman, while using one blue, used two *light yellow* glasses; hence the absorption of the more refrangible blue and violet might not be sufficiently complete, and the blending of those colours would cause the ashy blue, &c., which he observed.

As these changes are shown to be owing to the disappearance of the carbon lines, the glasses may be used with greater confidence in the accuracy of their indications; and for use in the workshop are much better adapted than a delicate instrument like the spectroscope.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

PHYSICAL AND MATHEMATICAL SECTION.

March 28th, 1871.

E. W. BINNEY, F.R.S., F.G.S., President of the Section, in the Chair.

MR. BROTHERS, F.R.A.S., after some preliminary remarks as to the chief objects of the English Eclipse Expedition to Sicily, in December last, exhibited on the screen a series of photographs illustrating, in the first instance, the means adopted for obtaining photographs of the eclipse. A series of pictures was then shown illustrating the corona as photographed during the eclipses in 1860, 1868, and 1869, and the whole of the pictures taken during the totality in 1870 at Syracuse. These were shown in comparison with the pictures taken in Spain by the American observers, and also with sketches taken by members of the English expedition in Spain. These illustrations showed in a remarkable manner the advantages of photography in depicting phenomena such as are seen during eclipses of the sun—the strict identity of the positions of the rifts or dark spaces in the corona being shown most perfectly. The identity of those rifts was also shown by comparison with a drawing made by Professor Watson at Carlentini, in Sicily.

During the evening Dr. Roscoe, F.R.S., explained the importance of spectrum analysis in investigating the solar phenomena, and described the preparations he had made for viewing the eclipse from his station on Mount Etna, about 5000 feet above the sea-level.

The photographs and other illustrations were exhibited by means of Mr. T. Harrison's powerful electric apparatus.

Annual Meeting, April 25th, 1871.

E. W. BINNEY, F.R.S., F.G.S., President of the Section, in the Chair.

The following gentlemen were elected Officers of the Section for the ensuing year:—

President—Joseph Baxendell, F.R.A.S.
Vice-Presidents—E. W. Binney, F.R.S., F.G.S., Alfred Brothers, F.R.A.S.
Secretary—G. V. Vernon, F.R.A.S., F.M.S.
Treasurer—Thomas Carrick.

"*Performance of the Electro-Magnetic Engine.*" By the Rev. H. HIGHTON, M.A.

(1). I am sure that Dr. Joule is a sufficient lover of truth not to feel offended if I submit his last explanations on this subject to the test of facts and experiments.

Not having myself the means of trying experiments with sufficient accuracy to venture to publish results, I will make use only of M. Favre's and Dr. Joule's own experiments.

(2). The whole basis of Dr. Joule's new reasoning is, that when a magnetic engine works rapidly less heat is evolved and more absorbed in it. Taking his own figures as a basis, I find he calculates that when the current is reduced to one-half what it was when the engine was at rest, the heat evolved *per hour* would be one quarter, and *per equivalent* of *zinc* consumed one-half. Now let us take the measurement by M. Favre's calorimeter (*Comptes Rendus*, vol. xlv.). When the engine was at rest, the calorimeter in which it was placed showed, per equivalent of zinc consumed, 2219 heat-units. When it worked slowly, raising a weight, it evolved 2947 units, and when it worked rapidly, raising no weight, it showed 4769 units. In that case, therefore, the effect was exactly the reverse of what Dr. Joule supposes.

(3). I have taken Dr. Joule's own experiments described in the *Philosophical Magazine*, vol. xxviii., and have calculated, on the data he gives, what weight ought to have been raised in each experiment. I subjoin a table of what should have been raised and what actually was raised:—

Expt.	Foot-pounds calculated.	Actual.
I.	19,377	21,100
II.	18,628	17,820
III.	11,533	8,800
IV.	11,232	9,000
V.	17,416	10,031
VI.	18,033	12,673

In order that any mistake I may have made may be detected, I subjoin the calculations themselves in an appendix. The numbers are calculated on the supposition that the resistance of the battery could be neglected. If Dr. Joule in those experiments acted on the erroneous principle, into which he was misled by Jacobi, that the resistance of the wire should be equal to that of the battery, each of the above calculated numbers should be reduced by one-half, which, in every case, would make the work actually done considerably more than the calculation, in some cases more than double.

(4). Let me next observe that if, instead of a wire 389 feet long, and 1-16th of an inch in diameter, Dr. Joule had taken one which was half the length and half the section, all his figures would apply equally well; or, again, a wire of German silver a quarter the length, and with four times the resistance; or, to take an extreme case, a wetted cord enclosed in an insulating tube 1-100th part the length, and with 100 times the resistance.

(5). Dr. Joule when he demonstrates that there is no variation in economy, whatever the arrangement of the conducting metal, or whatever the size of the battery, demonstrates too much; for it would follow from this,

that no diminution in the size of the battery would affect the result injuriously. Why, then, should he prescribe a battery of such a size that the resistance may be neglected? Take, again, his own figures in the 4th vol. of "Sturgeon's Annals." By reducing his battery from 40 pairs to 10, he increased his economic duty from 65·00 to 97·00 or 50 per cent.

(6). But in reality Dr. Joule's views in 1840 were more correct than they are now; for he was then not so far committed to the theory of the mechanical equivalence of heat. In 1840 he allowed that an economy could be effected by increasing the quantity of wire. Let us see whether he *was* right then, or whether he *is* so now. In his experiments in 1845 he used twice as much wire in his first two experiments as in his four last. What was the consequence? In his first two experiments the average of foot-pounds per hour was 19,460 and duty per grain of zinc 98·35. In the four last experiments the average per hour 10,125, and duty per grain of zinc 51·8, thus clearly showing, that doubling the quantity of wire nearly doubled both the actual work done and the economical duty.

(7). Again, a comparison of his two first experiments would tend to prove that reducing the intensity below one-half reduces not only the work done per hour, but the duty also, instead of increasing it. For the full current being 2232, a reduction to 920 produced 21,100 foot-pounds of work per hour, and a duty of 102·9; whereas a reduction to 850 (by increasing the turns from 140 to 180 per minute) produced only 17,820 foot-pounds of work per hour, and a duty of only 93·8, or nearly 10 per cent less.

(8). Dr. Joule's accurate and most valuable experiments are still the great storehouse of facts on this subject. What I contend is, that they disprove, not prove, his own theory.

Dr. JOULE said in noticing Mr. Highton's remarks,—I would refer him to my paper on the calorific effects of magneto-electricity and the mechanical value of heat, published in the *Philosophical Magazine* for 1843, vol. xxiii. He will there find it stated, pp. 274, 351, as the result of my experiments, that the heat evolved by the wire of my revolving electro-magnet varied with the square of the current passing through it, and was not affected by the resistance presented by magneto-electric induction in consequence of the working of the electro-magnetic engine. This fact is the basis of my reasoning in that paper, and the neglect of it has involved Mr. Highton in errror, as may be seen in his reply to Mr. Apjohn's most lucid exposition of the true theory in the CHEMICAL NEWS, vol. xxiii., p. 105.

The correctness of Jacobi's formula for the proper arrangement of the wires of a battery to produce the maximum magnetic effect is not necessarily connected with the subject of economy of work. Nevertheless I may refer Mr. Highton to my experiments on this subject in "Sturgeon's Annals" for 1839, by which I showed that the attraction of electro-magnets for one another is proportional to the square of the current between very wide limits.

Mr. Highton seems to forget, when commenting upon the large amount of duty obtained in the first two experiments of my paper with Scoresby, that in them the theoretical duty was also greater than in the others, owing to the current being worked down to a lower intensity. Another reason, explained in the paper was, that in those two experiments, recently mixed, and therefore hot solutions were used in the battery, the potential of which was thereby increased.

Mr. Highton is in error if he supposes that my paper in the *Proceedings* for March 21st contains a new theory, or that I have abandoned any of my original views. My object in that paper was simply to place the true theory in a form in which it might be easily understood by those who have not worked on the subject.

NOTICES OF BOOKS.

Alkali Act, 1863. Seventh Annual Report by the Inspector of his Proceedings during the year 1870. Presented to both Houses of Parliament by command of Her Majesty, 1871. Eyre and Spottiswoode.

The end for which the Alkali Act was passed, may be considered as attained; but there has arisen from the indefatigable labours of Dr. Angus Smith, a new branch of chemical science—chemical climatology. The importance of this new science it would be difficult to exaggerate—the likelihood that in a few years there will be some standard to which may be referred the paradoxical conclusions drawn from the statistics of the death-rate in towns as an indication of their healthiness, must claim for it almost general attention. The results of Dr. Smith's endeavours to establish such a science form the principal portion of the report for this year. He says:—

"The results do not in principle differ from those obtained last year, but the figures are more numerous, and it seemed advisable to calculate again the averages, often adding the new experiments. This has been done for the rain. . . . It has appeared to me necessary to examine the atmosphere in order to see what amount of muriatic acid it contained in places where that is manufactured. From that I was led to examine it also in other places, in order to make a full series of comparisons, and next I was naturally conducted to a comparison of the amount of muriatic acid and chlorides in relation to other substances. This part of the work may now be said to be accomplished, and the results, I hope, will be of use in all sanitary inquiries in future whenever the chemical method is adopted. That it will be adopted more frequently now is my belief. It is safer to examine the condition of the air by a few chemical experiments than by waiting to see how many deaths take place in a thousand of the population."

The report first considers the method of introducing the air into sample bottles; both the air-pump and a loose bellows-pump were employed. The results proved that the cumbrous air-pump might well be dispensed with for the bellows-pump, thus admitting the collection of samples with greater facility. Then follows an examination of the rain for different localities, the Inspector placing more reliance on air-washings than on the examination of continued rain, because when very wet the rain gives an exaggerated idea of the purity of the atmosphere; and when the season has been very dry, there obtains, on the other hand, an exaggerated idea of the impurities. The amount of chlorides in the rain depends mainly on two causes—the distance from the sea, and the distance from manufactures. Valencia has been taken as 100, as affording a good specimen of sea atmosphere. Sulphuric acid or sulphates measures the manufacturing activity and also the decomposition, the amount increasing inland on account of vegetable and animal matter. Ammonia, the result of decomposition, is a measure of the sewage in the air; but by itself it is not impure. On the contrary, the amount of albumenoid ammonia is a measure of the non-purified sewage in the air, and includes the most dangerous substances, germs of living things, vegetable or animal.

The following are some of the comparative results:—

		Parts per million.
Ireland, Valencia	1·00	0·034
Scotland, inland	1·26	0·043
,, sea-coast	3·11	0·1055
England, inland	3·15	0·108
German specimens	3·59	0·122
Liverpool	4·67	0·159
Runcorn	5·59	0·190
London	6·03	0·205
Manchester, 1869	6·21	0·211
Manchester, 1870	8.32	0·283

		Parts per million.
Scotland, towns (not Glasgow)	6·23	0·212
England, (6 manufacturing towns)	6·26	0·213
Glasgow	8·82	0·300

But these are not a tithe of the many observations. There is one very notable fact, that in all the tables the result always shows badly for Glasgow.

In the case of the practical application of the Alkali Act, Dr. Smith advises, where damages are complained of relatively to two or more works in the locality, that a system of valuation should be established, so that the well-regulated works should not suffer equally with the careless manufacturer. He says:—

"Such a system if acted on by authority might be united with the first extension of the Alkali Act. It would give a right of inspection of works from which acids escape, at least when complaints were made. Coal smoke may some day be included, especially when people for economy burn a very inferior coal. To confine the extension to acids would avoid any great innovation. Acids are easily estimated, and it would be enough to give the acidity without stating the separate amount of each acid. We cannot very easily distinguish the different effects, and it is of little consequence to a man whether his land is poisoned by muriatic acid or sulphuric. At present this kind of distinction is the only consolation I can give to those who complain of injuries done by gases other than muriatic acid, and these complaints are the more numerous class."

CORRESPONDENCE.

ON THE CHARRING-POINT OF TEXTILE FABRICS.

To the Editor of the Chemical News.

Sir,—In connection with the concluding portion of Dr. Crace Calvert's experiments "On the Action of Heat on Protoplasmic Life and on Cotton Fabrics," and reported in the Chemical News of last week, permit me to mention that two and a half years ago I made a number of experiments in this direction, when altering the disinfecting chamber belonging to this borough, where previously the temperature rarely exceeded 212° to 220° F.

The object, of course, was to determine a safe point up to which the heat of the chamber could be raised, without damaging the clothing and bedding through scorching, placed there for supposed disinfection.

The substances taken were thin deal shavings, coarse bleached flannel, tissue-paper, piece of mohair dress, piece of print dress, piece of print muslin, piece of curtain muslin, together with some cotton-wool.

All the specimens were suspended freely, so that the heated air came fully in contact with every part of them; the thermometer was also similarly suspended. After half an hour's exposure at 200° F., and afterwards a like time at 250° F., the whole were found to be intact and unchanged. At 290° F. the fabrics, or some of them, gave off a vapour having the odour of scorching; but at 300° F. they were without visible detriment or change of colour. On continuing the heat for half an hour at 330° F., the shavings were found of a faint brown colour, barely perceptible; the other samples were of a slightly higher colour. The cotton-wool possessed a scorched smell, but such was not discernible in any of the others.

The temperature was now raised to 350° F. and continued as in each of the other tests for half an hour. The colour of each experimental piece was a little heightened, the cotton-wool and the flannel most so, whilst least of any the tissue-paper and print muslin.

I did not consider, judging from previous and more recent experiments, that the colouration was permanent, but would wash out, nor that the fabrics were at all damaged.

Half an hour's exposure at 365° to 370° F. gave a permanent scorching to all the specimens, the shavings, however, least so. At this temperature all the pieces were considered as damaged, although not materially.

I have always taken the view mentioned by Dr. Calvert, that the ordinarily employed temperatures of disinfecting stoves are inoperative upon germ life, and the virus of contagia. It is only right, however, to state that in this town the Public Chamber has the furnace within it, and as coke is the material employed, the whole place with the articles under treatment is impregnated strongly with sulphurous acid that very likely has a destructive action upon germs. Nevertheless, I am strongly of opinion that much more satisfactory results would be attained by thoroughly impregnating infected materials with the vapour of phenol at a moderate temperature, and in the presence of steam.

The results here arrived at as to the destructive action of heat upon such things as are likely to require disinfection, differ from those recorded by Dr. Calvert; but it must be noted that the conditions of experiments vary, the present ones are more in accordance with actual practice.—I am, &c.,

Richard Weaver, C.E.

The Sanitary Laboratory,
Leicester, Sept. 25, 1871.

THE LECLANCHÉ BATTERY.

To the Editor of the Chemical News.

Sir,—I find that what I said about the Leclanché battery at the Post Office has led to a false impression, which I am asked to correct. I learn on the best authority that it is used only on circuits of considerable resistance, and not much work, for which it is found very suitable. I had good authority for what I said, but it no doubt referred to some isolated trials on short circuit, and with hard work. It is obvious that it would not be ordinarily used for such purposes.—I am, &c.,

H. Highton.

Putney, Oct. 2, 1871.

VALENCY OR ATOMICITY.

To the Editor of the Chemical News.

Sir,—A reply to "W. H. O's." letter in the Chemical News, vol. xxiv., p. 156, will be found in two principles of the modern theory of atomicity.

Let me illustrate the first by diatomic oxygen. The molecule of oxygen gas contains two atoms, and the theory regards these as united by each of the atomicities of 1 atom being engaged or satisfied by an atomicity of the other, or, in other words, by an "exchange of two atomicities." But we may conceive two oxygen atoms united by exchanging only one atomicity, leaving vacant another in each atom, and so forming the diatomic radical $(O_2)''$. The molecular constitution of ozone, $(O_2)''O$, proves the existence of such a radical. Hence—

(1). Two atoms of a polyatomic element may, by an exchange of atomicities, give rise to a radical of an atomicity corresponding to the number of points of affinity left vacant.

The second principle might almost be called an extension of the first. It is—

(2). In a single atom of a polyatomic element, a pair, or several pairs, of the atomicities may satisfy each other.

This leads to a distinction between atomicity and valency. The former is invariable, being determined by

the greatest number of monatomic atoms (or radicals) which an atom ever fixes. But the valency of the same atom may vary from one molecule to another, for it denotes only the number of atomicities which the atom actually satisfies in a given molecule. Obviously this will either equal the atomicity, or be less by some *even* number.

Fe is now regarded as hexatomic, from its analogy with Cr, and from its maximum valency, exhibited by potassium ferrate, $Fe\{^{VI}_{IV} O''_2(KO)'_2\}$. By (2), it may also be quadrivalent, as in $Fe^{IV}S''_2$; or bivalent, as in Fe"O. By (1), two quadrivalent atoms can exchange an atomity and produce the sextivalent radical, $(Fe^{IV}_2)^{VI}$.

The pentatomicity of N is proved by its maximum valency in $N^{V}(H_4Cl)$. By (2), it may be trivalent as in $N'''H_3$, or monovalent as in $O(N'_2)''$. Nitric oxide appears anomalous, but just as N_2O_4 splits up into $2NO_2$ at a temperature below 100°, so NO may be the result of *dissociation* by even an extremely low temperature, and the true formula for nitric oxide $(N'''^{IV}_2)O_2$.—I am, &c.,

R. ROUTLEDGE, B.Sc.

Bowdon, Cheshire,
Sept. 30, 1871.

ESTIMATION OF PHOSPHORIC ACID.

To the Editor of the Chemical News.

SIR,—In answer to Mr. B. J. Grosjean's questions (CHEMICAL NEWS, vol. xxiv., p. 33) relative to my paper on the above subject, I would say that by "pure aluminic sulphate" I meant, not the normal salt, but one that contained only aluminic, sulphuric, and hydric oxides. Had I used the normal salt I should not have published results obtained by so old and well-known a process as that of the estimation of aluminic oxide by ignition. The same is true of the ammonio-sodic phosphate.

I should be very much pleased if Mr. Grosjean would give us the results which he has obtained, both by the aluminic sulphate and the mercurous nitrate processes.—I am, &c.,

CHARLES E. MUNROE.

Cambridge, Mass, U.S.A.,
Sept. 1, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, September 4, 1871.

This number contains the following original papers and memoirs bearing upon chemistry and allied sciences:—

Relation Existing in the Sun betweeen the Protuberances and other Remarkable Parts.—Rev. A. Secchi, S.J.—A lengthy and very interesting memoir elucidated by engravings.

Some Observations on the Simultaneous Distillation of Water and of certain Alcohols Soluble therein.—J. Pierre and E. Puchot.—The conclusions which may be drawn from the facts communicated in this exhaustive essay are:—When a mixture of water and amylic alcohol, or of water and butylic alcohol, is submitted to distillation, the temperature of the boiling liquid remains the same until there remains in the retort only one of the two liquids. This temperature of ebullition is always lower than that of the boiling-point of the most volatile of the two liquids—in the instance here mentioned below 100°. For each of these mixtures there exists a constant *rapport* between the proportions of water and alcohol which pass over by distillation, but this *rapport* varies with the varying alcohols, being 2 to 3 in the case of amylic, and 1 to 5 in the case of butylic alcohol and water mixed. When a mixture of butylic and amylic alcohol is made along with water, the temperature of the ebullition is not constant, but varies according to the varying proportions of the alcohols used for the mixture; but the boiling temperature remains always lower than the boiling-point of the most volatile liquid present.

On Petroleum.—H. Byasson.—This memoir treats on petroleum as regards its composition, its industrial applications, its origin, and the best means of ascertaining its inflammability; this latter particular is ascertained by the measurement of the pressure of the vapours of the petroleum exerted upon a column of water—a kind of manometer tube.

Spectrums Exhibited by Carbon, Boron, Silicium, Titanium, and Zirconium.—L. Troost and P. Hautefeuille.—The contents of this highly valuable paper are not suited for useful abstraction; an observation also relating to the following paper:—

Spectra of Sulphur, Selenium, and Tellurium.—A. Ditte.

Preparation and Properties of a Sulphuret of Selenium.—A. Ditte.—After referring to the researches of Berzelius on this subject, the author states that he has prepared a crystalline compound of the two elements alluded to, by the action at a low temperature (between 0° and 5°) of sulphuretted hydrogen on a concentrated solution of selenious acid, and by purifying the precipitate thus formed by the aid of benzine and sulphide of carbon. The resulting compound is a crystalline, orange-yellow, transparent substance, consisting, in 100 parts, of:—Sulphur, 28·68; selenium, 71·40. This body is produced by the following reaction:—$SeO_2+2HS=2HO+SeS+S$. The free sulphur is soluble in benzine or sulphide of carbon; sp. gr. of the compound, at 0° = 3·065.

Formation of Secondary Monamines by the Action of the Bases of the Formula $C_nH_{(2n-7)}H_2N$ upon the Chlorhydrate of Naphthylamine.—C. Girard and G. Vogt.—The contents of this paper (the first instalment of a memoir on this subject) are, notwithstanding their intrinsic value, not suited for abstraction, on account of the large number of lengthy and complex formulæ required for the proper elucidation of the subject.

Jahrbuch der Kaiserlich-Königlichen (Austro-Hungarian) Geologischen Reichsanstalt, No. 2, 1871.

In addition to a number of papers treating on the geology and mineralogy of the Austro-Hungarian Empire, this number contains the following papers relating to chemistry and allied sciences:—

Phosphorite Deposits Situated on the Banks on the Dniester, in Russian and Austrian Podolia, and in the Bukowina.—F. Schwackhofer.—This lengthy essay, illustrated by several tabulated forms and engravings, treats on the phosphorite in a mineralogical, genetical, and chemical point of view. It appears that, on the whole, the deposits of this mineral are very rich in phosphoric acid, and in many respects the composition of the nodules of this phosphorite approaches that of pure apatite. Among the minerals, petrified wood is met with, which has a hardness = 4; sp. gr., at 17° = 2·937. The percentage composition of this mineralised wood (which, however, has a distinctly organised structure, and has been thereby ascertained to belong to the *Pinus* species) is:—Tribasic phosphate of lime, 67·46; free phosphoric acid, 2·26 (the wood exhibits an acid reaction when brought into contact with moistened litmus-paper); fluoride of calcium, 9·33; carbonate of lime, 13·56; carbonate of magnesia, 0·96; sulphate of lime, 3·26; oxide of iron, 0·26; alumina, 0·05; silica, 0·04; organic matter, 2·99; water, 0·44.

Simple Instrument for Detecting, as well as Measuring, the Intensity of Earthquakes.—Dr. E. Stahlberger.—The description of an ingeniously arranged contrivance; illustrated by engravings.

Microscopical Investigation of the Pechstein of Corbitz.—Dr. B. Behrens.—The mineral alluded to is an unisilicate which, from its more pitch- than glass-like appearance, is termed pitch-stone The contents of this paper treat on the microscopical structure of this mineral, which structure is illustrated by several engravings.

Account of the Analyses and Investigations Made in the Laboratory of the Geological Institute.—K. Ritter von Hauer.—This exhaustive paper contains the results of a very large number of analyses and investigation of various minerals, including coals, coke, brown coal, peat, pyrites, limestones, iron, and other mineral ores; these analyses are chiefly of local interest only.

The American Journal of Science and Arts, September, 1871.

This number contains the following original papers relating to chemistry and allied sciences:—

Nature and Duration of the Discharge of a Leyden Jar Connected with an Induction Coil.—O. N. Rood.—Second part of an essay on this subject, illustrated with woodcuts and diagrams.

Memoranda Concerning the Introduction of the Manufacture of Spelter into the United States.—J. Wharton.—An important contribution to the metallurgical industry of the great Trans-Atlantic Republic.

Destructive Distillation of Light Petroleum Naphthas at Comparatively Low Temperatures.—S. D. Hayes.—Reserved for reproduction; an observation also applying to the following paper:—

Observations on the Colour of Fluorescent Solutions.—Dr. H. Morton.

Mineralogical and Chemical Composition of the Meteoric Stone that Fell near Searsmont, Maine, May 21, 1871.—J. L. Smith.—The sp. gr. of the specimen examined = 3·701. Nickeliferous iron and stony matter separated by mechanical analysis gave, for 100 parts:—Stony matter (including a little sulphuret of iron), 85·38; nickeliferous iron, 14·62. The iron afforded:—Iron, 90·02 per cent; nickel, 9·05; cobalt, 0·43; phosphorus and copper, not estimated. The portion soluble in nitro-hydrochloric acids (soluble, 52·3 per cent; insoluble, 47·7) gave, in 100 parts:—Silica, 40·61; protoxide of iron, 19·21; magnesia, 36·24; sulphuret of iron (accidental constituent, only present as mechanical mixture), 3·06. Composition of insoluble part:—Silica, 56·25 per cent; protoxide of iron, 13·02; alumina, 2·01; magnesia, 24·14; alkalies, NaO,KO, with trace of LiO, 2·10. Composition of stone:—Nickeliferous iron, 14·63 per cent; magnetic pyrites, 3·06; olivine, 43·04; bronzite, a horneblende, with a little albite or orthoclase and chrome-iron (small black specks, not estimated), 39·27.

As usual, this number contains several valuable original papers bearing upon astronomy, geology, and natural history.

Journal für Gasbeleuchtung und Wasserversorgung, Nos. 15 and 16, 1871.

These numbers do not contain any original papers besides those specially bearing upon subjects pertaining to gas- and water-works' engineering and management.

Annales des Mines, Nos. 5 and 6 (double number), 1870.

The original papers contained in this number do not treat on subjects related to chemistry or allied sciences.

Nos. 1 and 2 (double number), 1871.

This number contains the following original papers relating to chemistry and collateral sciences:—

Essay on Red-Lead, or Minium, and a New Method of Preparing it.—G. Mercier.—This paper, illustrated by engravings, describes a series of experiments made on the large scale with the view to obtain a more rapid, less expensive, and less tedious method whereby massicot may be converted into red-lead.

Note on the Use of Nitro-Glycerine in the Working of Marble Quarries of the Valley of La Vire, near Saint Lô, La Manche, France.—H. Harlé.—This paper contains an account of the preparation of nitro-glycerine on the spot where it is to be used for blasting purposes in quarries or mines; it appears that, in this way, the use of nitro-glycerine has become very prevalent in mining operations in the country above named.

Exhaustive Essay on the Various Explosive Substances Used in Mining Operations.—A. Henry.—This essay contains the following sections:—Elements of the comparative value of the different explosive substances used in mining operations—viz., gunpowder, gun-cotton, nitro-glycerine, dynamite, dualine, and lithofracteur; mode of applying these materials, and results obtained therefrom in practice; on conditions of safely manufacturing, carrying, and warehousing blasting-powder; conclusions. This important essay is illustrated by engravings.

Memoir on the Siebengebirge and the Eifel.—R. Zeiller.—A geologico-metallurgical monograph, illustrated by maps and charts.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, July, 1871.

This number only contains the two following original papers relating to physico-chemical sciences:—

Formation of the Anhydrite met with along with Rock-Salt. G. Rose.—This exhaustive chemico-mineralogical monograph does not admit of any useful abstraction. As is usual with the eminent author, this essay testifies to his high accomplishments and excellent method of research.

Electrical Oscillations Observed in Rectilinear Conductors after the Opening of a Collateral Current.—Dr. J. Bernstein.—Illustrated by woodcuts and several tabulated forms.

Journal de Pharmacie et de Chimie, June, 1871.

This number contains the following original papers and essays:—

Researches on the Products of the Oxidation of the Principal Normal Alcohols.—J. Pierre and E. Puchot.—This lengthy essay contains the following sections:—Introduction, treating on the principal products of oxidation of normal alcohols in general; preparation of the amylic valerianate, $C_{10}H_9O_3,C_{10}H_{10}O$, by the oxidation of amylic alcohol; preparation of the butylic butyrate, $C_8H_7O_3,C_8H_9O$; preparation of propylic propionate, $C_6H_5O_3,C_6H_7O$.

Electrolysis of Phthalic Acid.—E. Bourgoin.—This essay contains the description of the result of a series of experiments instituted by the author, with a view to ascertain the effect of electricity upon phthalic acid and its salts. The acid is decomposed, the reaction being represented by the following formula:—

$$C_{16}H_6O_8=(C_{16}H_5O_8+O_3)+H_3;$$

at the positive pole, $(C_{16}H_5O_8+O_3)+H_2O_2=C_{16}H_6O_8+O_3$. Solution of neutral phthalate of potassa, reaction:—

$$C_{16}H_6O_8+12O_2=3H_2O_2+4C_2O_4+4C_2O_2.$$

Phthalate of potassa and free alkali; this mixture behaves exactly as the neutral salt.

General Conditions of the Production of the Phenomena of Incandescence; Origin of these Phenomena.—A. Boillot.—This essay treats exhaustively on the phenomena of combustion in a wider sense, including the spontaneous and sudden decomposition of such substances as anhydrous nitric acid, chloride of nitrogen, iodide of nitrogen, and nitro-glycerine. The author reduces the phenomena alluded to simply to "*mouvement de la matière*," that is to say, the succession of the different positions a body takes up.

On Iodated Cotton.—C. Méhu.—The contents of this paper bear upon the properties and preparation of a pharmaceutical compound of cotton wool, impregnated with 5 per cent of iodine, and employed for external use.

Polytechnisches Journal von Dingler, second number for July, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Gold-Ruby Glass.—W. Müller and Dr. F. Knapp.—This very exhaustive memoir treats on that kind of glass which owes its beautifully red-purplish colour to gold. The first portion of this monograph contains a review of the literature of the subject alluded to, and of the various theories and opinions held on the condition of the gold while acting as a pigmentary or staining matter. The other sections are the following:—The gold—from this part of the memoir it appears that the quantity of gold required to impart colour to the glass mass is very small indeed, since 1 part of gold in 100,000 of the metal (as the molten glass mass is technically called) distinctly yields a rose-red colour; influence of the composition of the glass mass; influence of temperature and of the length of time taken by the smelting of the glass mass; influence of the so-called glass gall; influence of the cooling; colours of gold-stained glass and the variations thereof; the annealing; constitution of the gold-containing glass. The authors did not succeed in discovering by experiments what the condition is of the gold in the glass; the chief reason of this failure is that the quantity of gold is infinitesimally small.

On Nickeling and Cobalting by the Wet Way.—Dr. F. Stolba.—The author's process, described at great length, is based upon the fact that nickeling and cobalting by the wet way (that is to say, the coating of other metals with a more or less thick film of either nickel or cobalt) succeeds by using along with either a solution of or the dry salt of nickel, chloride of zinc in dilute solution, metallic zinc, and some pure hydrochloric acid.

Cleaning Glass Vessels wherein Petroleum has been Kept.—Dr. F. Stolba.—Thin milk of lime, used for washing glass vessels wherein the liquid alluded to has been kept, forms with the petroleum an emulsion, and renders it possible to remove any traces, and, by the addition of a small quantity of chloride of lime to a second washing with milk of lime, even the smell so completely as to render the vessels so cleaned fit for pouring and keeping beer therein; if warm milk of lime be used, the operation, which otherwise takes considerable time for completion, is rendered shorter.

Detection of Woody Fibre in Paper.—Dr. J. Wiesner.—A microscopico-technical paper. By the proper application of the microscope, the author finds that not only can woody fibre be detected in paper, but even the kind of wood recognised which has been pulped.

Description of an Apparatus suited for Exhausting Oil Seeds by means of Canada Oil (Petroleum Spirit) for the Preparation of Oils to be Used as Food and other Purposes.—Dr. H. Vohl.—Illustrated by engravings.

Comparison of the Relative Value of Canada Oil and o Sulphide of Carbon for the Purpose of Extraction of Oils from Seeds.—Dr. H. Vohl.—The sp. gr. of well-refined Canada oil = 0·68; that of purified sulphide of carbon = 1·265. 100 litres of the former liquid weigh 68·0 kilos.; the same quantity of the latter weigh 126·5 kilos. While, abroad, the price of 100 litres of the Canada oil is such that, as compared with the same bulk of sulphide of carbon, the former liquid costs 8 thalers 29·4 sgr. less than the latter (the thaler is equal to 3 shillings, the silbergroschen is equal to about 1 penny).

Composition of a Dressing (Weaver's Glue) to be Applied to Calico Fabrics, and Obtained from France.—Dr. T. Finckh.—The author's aim in testing the dressing was to find out the best means of preparing it for use, the result being that 2 parts of caustic soda are used along with water to saponify from 4 to 5 parts of palm oil; to the resulting soap immediately sufficient hot water is used to dissolve it, and next 30 parts of glycerine (sp. gr. = 1·214) are added to the yet hot fluid. After cooling, 8 parts of wheaten starch are stirred through the fluid, which is next brought up with water to weigh 100 parts. A small quantity of carbolic acid is added to prevent fermentation of this mixture, which should be kept in a cool place, and not made up in too large quantity at once; for use as dressing, to 100 lbs. of potato-starch from 6 to 8 lbs. of this mixture are taken.

Easy Method of Testing Soft, or Potassa, Soaps for the Quantity of Oil or Fat and Alkali Contained therein.—Dr. U. Gräger.—Reserved for full translation.

Notes on Ultramarine.—C. Fürstenau.—Microscopical research of the pigment alluded to proves that it is not a homogeneous mass, but contains:—(1) A blue-coloured glass-like sintered mass; (2) deep blue-coloured grains of unequal size, the larger of which exhibit a white-coloured nucleus; (3) unacted-upon kaolin; and a colourless enamel-like substance. The last-named materials were found by the author in all kinds of ultramarine, even of the best makers.

Strong Vegetable Glue.—A. Selle.—This preparation is a mixture of nitrate of lime, water, and pulverised gum, in the proportion of 2, 25, and 20; the solution of the nitrate of lime contains 33·3 per cent of that salt. This glue may be used for glass, porcelain, wood, cardboard, marmor, &c.

Les Mondes, September 7, 1871.

The original papers and essays, relating to chemistry and allied subjects, met with in this number are the following:—

Dry Distillation of Wood.—M. Maiche.—From this lengthy paper, written by a practical distiller of wood, we quote the following particulars:—This industry does not pay unless the greatest care is taken to utilise advantageously all the products, which, for 100 kilos. of wood submitted to distillation, amount to 50 kilos. of raw produce, wherein are contained:—Methylic alcohol, 2 kilos.; crystallisable acetic acid, 3 kilos. (*i.e.*, that quantity of glacial acetic acid may be obtained): tar, 10 kilos.; water, 35 kilos.; and a residue of charcoal, weighing 22 kilos. Dry wood, submitted to distillation at 700°, yields, among other products, an oil which, like paraffin oil, can be used in lamps; it boils at 90°, and is devoid of smell. The author has also tried, as yet only on a small scale, to submit chopped-up wood to distillation in water containing 10 per cent of sulphuric acid; the result is the formation of acetic acid very abundantly, and of a peculiar aromatic principle insoluble in cold water.

Notes on the Mineral Statistics of Italy.—M. Giordano.—This paper, from the hand of the Chief Inspector of Mines for the kingdom just named, contains information on the extraction of sulphur (by far the most important of the Italian minerals); iron ores and the iron manufacture; copper, lead, and zinc ores, which are exported chiefly to England and Belgium, owing to the fact that Italy lacks mineral fuel; gold, of which annually about 400 kilos. are obtained; and, lastly, an account of the engineering establishments of Italy.

September 14, 1871.

Among the original matter contained in this number the following relates to chemistry and collateral sciences:—

Ammonia Engine.—C. Tellier.—An account of the mode of action and principles of the application of ammoniacal gas instead of steam for the purpose of imparting motion to machinery. This application is based upon:—(1) The great solubility of ammoniacal gas in water; (2) the facility of liquefying that gas; (3) the fact that at ordinary temperatures the gas exerts a pressure sufficiently strong to be industrially applied; (4) the possibility of superheating ammoniacal vapours without a too high temperature; (5) the fact that the gas can be dissolved in water and recovered and again applied for use.

Exposition of an Economical Method of Application of Steam.—M. Autier.—Although not exactly belonging to the subjects usually treated of in our pages, we call attention to this subject, which is here treated of in the shape of a review of a book, the chief theme of which is cheap motive force with all kinds of fuel. It appears from the *resumé* here published that the author, a practical engineer, is well up to his subject, which entails economy of construction of engines and boilers, economy of fuel and labour, and a decrease of wear and tear.

Elements of Organic Chemistry.—Dr. Sacc.—Attention is here called to this work, recently published at Paris by Lacroix. From the preface of this book it appears that the author's aim has been to produce what he terms "Première Tentative d'une Chimie Naturelle et Pure." The excellent editor of *Les Mondes* speaks highly of the volume, which is sold at 2s. 6d., and contains 478 pages.

September 25, 1871.

This number does not contain any original papers relating to chemistry and collateral sciences, but we call attention to a paper:—

On Portable Tramways for Agricultural Use.—M. Corbin.—Illustrated by engravings. The contrivance is intended especially to facilitate the removal of root-crops from the field, by a rapid and very cheap method of conveyance which can be applied everywhere.

Hints for the Proper Arrangement of Meteorological Observatories.—V. Regnault.—Illustrated by engravings.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, September 7, 1871.

This number, the first of a new volume, opens with an excellent preface which, undoubtedly, proves that "La France intelligente, éclairée, et libérale ne périt pas, et n'est nullement éteinte." The following original matter is met with in this number:—

Chenot's Process of Iron and Steel Manufacture.—C. Mène.—The author describes at length a mode of manufacturing iron by which the metal is obtained in a spongy state instead of being smelted. The operation is conducted in peculiarly arranged furnaces, the ore being first calcined. The spongy metal is next converted into steel by being first soaked in either molten resin, coal-tar, or other suitable similar substance, and then calcined. The carbonated spongy mass is next ground to powder, and having been placed in moulds, is very strongly compressed, after which the solid lumps are put into crucibles and fused. It appears from experiments made on the large scale at Clichy, that the iron thus obtained (no mention is made of the nature of the reducing agent employed) is superior in every respect to that produced by blast furnaces; as to the cost of this process nothing is mentioned, but, since cast-steel of excellent quality, or malleable, or, if desired, cast-iron, can be produced at will, and the operation of puddling and refining are dispensed with, it is probable that the expense will not exceed that of the usual process, while the yield of metal from the ore is stated to be in favour of Chenot's process, by which phosphorus and sulphur are also eliminated.

Apparatus for Exhibiting the Phenomena of Cooling Water far below its Freezing-Point and the Effects of its Expansion on Freezing.—F. Hamel.—The description, accompanied by a woodcut, of a neat and highly instructive apparatus made by M. Alvergnat, Passage Sorbonne, Paris.

Description of Foucault's Heliostate, Constructed by J. Duboscq, Rue de l'Odéon, Paris.—C. Mène.—Illustrated by a woodcut.

Studies on the Chemical Dissociation of Bodies.—C. Mène.—The first portion of a well and clearly written essay on this subject.

NOTES AND QUERIES.

Electro-Deposition—Crimson Spirit.—(1). Can any of your readers tell me of a good practical method of depositing bright platinum on iron or copper? (2). Can aluminium be anyhow deposited by the battery? (3). How can I make "crimson spirit" used by silk dyers?—INQUIRER.

Electrical Phenomena.—A few days ago I stood near a person cleaning windows; I noticed that, after wiping the glass with a wet leather, she used an old silk handkerchief as a duster to dry the pane I also noticed that while the glass was being rubbed with the silk a crackling sound emanated from the pane. Taking notice of this circumstance I waited till the evening, when it was perfectly dark, and repeated the experiment thus:—In the first place, I took a pane and rubbed it with the handkerchief, and I thus obtained a number of flashes of light with crackling accompaniment. I then rubbed the pane with the wet leather, and again rubbed with the silk; the flashes and noise were both more decided than before, the former being very bright; with prolonged rubbing they gradually died away, but on rubbing again with the leather, and afterwards with the handkerchief, they again became bright and more copious. I repeated the experiments with different panes and on three different windows successfully. The kind of electricity is positive, as that of dry glass and silk. The experiments were conducted out of doors, and the weather at the time was cold, with a slight mist in the atmosphere. I have tried the experiment with a cotton instead of a silk duster with nearly equal success. The experiments have been repeated on subsequent evenings, sometimes successfully, and sometimes not, the former predominating over the latter. I have sent this notice of the above, because I have not yet seen a description of anything similar, and because it seems to prove that absolute dryness is not indispensable to electrical experiments, and to show that it is unnecessary to roast the apparatus to death, as is the common practice of some lecturers.—W. JESSE LOVETT.

TO CORRESPONDENTS.

D. R.—It will be better to keep the solution boiling or nearly so the whole time of passing the gas.

W. H.—Several kinds of laboratory-labels have been noticed in our columns; they have also been advertised in this journal.

J. P. Barnett, New York.—Wormley's "Micro-Chemistry of Poisons" is the only book we know of which treats on the subject.

BOOKS RECEIVED.

Flint. A paper read before the Geologist's Association, June 2nd, 1871. By M. Hawkins Johnson, F.G.S.

The Journal of the Iron and Steel Institute, vol. ii. London: E. and F. N. Spon.

Miscellanies. By John Addington Symonds, M.D., Selected and Edited, with an Introductory Memoir, by his Son. London: Macmillan and Co. Bristol: J. Arrowsmith.

On the Relative Powers of Various Substances in Preventing the Generation of Animalculæ or the Development of their Germs, with special reference to the Germ Theory of Putrefaction. By John Dougall, M.D., Glasgow. London: J. and A. Churchill, New Burlington Street.

Sixth Report of the Quekett Microscopical Club, and List of Members.

On the Economical Production of Peat and Peat-Charcoal. Liverpool: Peat Engineering and Sewage Filtration Company.

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Notices of Books. Progress of the Various Sciences. Recent Scientific Literature, &c., &c.

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FREDERICK J. SIDNEY, LL.D., Secretary.

THE CHEMICAL NEWS.

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NOTE ON A NEW SCOTCH ACIDULOUS CHALYBEATE MINERAL WATER.

By JAMES DEWAR, F.R.S.E.

IT is generally known that this country is extremely deficient in well-marked chalybeate waters. Plenty natural waters, containing small proportions of iron, are to be met with in the United Kingdom; but, with the exception of those of Tunbridge Wells, Harrogate, Sandrock (Isle of Wight), Heartfell, near Moffat, and Vicarsbridge, in the vicinity of Dollar, they contrast very unfavourably with those of the numerous spas of the continent of Europe. If we restrict ourselves to an examination of the chemical characters of the above-mentioned Scotch chalybeates, we observe that the iron is present in large quantities in the form of sulphate, along with sulphate of alumina, on which account they are more nauseous to invalids, and are at the present time rather unpopular.

Recently my brother, Dr. Alexander Dewar, Melrose, sent me for analysis a sample of a new well water, whose peculiarity had previously attracted his attention. A chemical examination of the water in question showed it to be a well-defined acidulous chalybeate, unusually rich in carbonate of iron. The following are the analytical details. (As the surface-water gets access at present, a very exhaustive analysis appeared unnecessary):—

	Grs. per gallon.
Carbonate of iron	17·5
Alumina	1·8
Silica	8·5
Sulphate of magnesia	7·8
Chloride of calcium	16·0
Carbonate of calcium	4·1
Alkaline chlorides	11·4
	67·1

Carbonic acid gas per gallon 40 cubic inches.

With the exception of the celebrated "Dr. Muspratt's chalybeate," at Harrogate, which contains 10·8 grains per gallon of carbonate of iron, along with 16·0 grains of protochloride, I do not know of any natural water in this country containing such a large proportion of iron in the form of carbonate. And it is to be observed that the water is not associated with a large quantity of other salts.

The well whence the foregoing sample was taken has not been long sunk, and its water is perfectly different from all of those in its immediate vicinity. Should it maintain its present character, I have no doubt that, judging from its own qualities, as well as from its favourable climatic situation, along with the general interest attached to the locality, this chalybeate is certain to recommend itself to the medical profession.

ON THE ESTIMATION OF SULPHUR BY BARIUM.

By E. F. TESCHEMACHER and J. DENHAM SMITH.

WE have read the remarks of Messrs. Nicholas Glendinning and Alfred Edger, in the CHEMICAL NEWS, on the "Estimation of Sulphur by Barium."

In our memoir on this subject we pointed out that when a boiling solution containing sesquioxide of iron, sulphuric acid, and a large excess of hydrochloric acid was precipitated by chloride of barium, and the resulting sulphate of barytes washed by moderately strong and hot hydrochloric acid, and finally, by boiling water, there might sometimes be observed on the sides and bottom of the beaker containing the filtrate and washings, after these had cooled and been allowed to stand for several hours, a film, which film we stated to be sulphate of barytes; adducing this observation as one proof amongst others of the solubility of sulphate of barytes in hot and moderately strong hydrochloric acid.

Now, the very first statement Messrs. Glendinning and Edger make, after announcing that they differ from our conclusions, is, "We attribute this (film?) to sulphate of iron" (*sic in orig.*).

In the face of the absurdities involved in this quotation, and the proof it affords of the incompetency of its authors, our would-be critics, to deal with any question of analytical chemistry, we take leave to decline following them through the opinions, contradictory statements, and unproved assertions which compose the rest of the remarks of these somewhat hazy writers of Newcastle-on-Tyne.

NOTES ON THE COLOUR OF FLUORESCENT SOLUTIONS.

By Professor HENRY MORTON, Ph.D.,
President of the Stevens Institute of Technology, N.J.

II.

I HAVE recently observed a curious action, which while it in no respect affects the general conclusions given in the CHEMICAL NEWS (vol xxiv., p. 77), nor the main observations on which they were founded, throws out the corroborative experiments by which I thought that they might be established when a spectroscope was not at hand.

Obtaining some very anomalous results of late, I was led to mistrust the action of the Geissler-tubes in which the solutions had been examined. These were of the ordinary kind of jacketed spirals, selected as being nearly identical in size and other particulars.

It had been observed from the first that the internal spiral gave a faint blue fluorescence, which could only be seen on close inspection, and in all cases the tube being but partly filled, it was considered that a light appearing in the part covered by the fluid, many times more bright than that from the uncovered part of the spiral, was sufficient evidence of fluorescence in the liquid.

Late experiments have, however, proved that this was not so. Any liquid, however devoid of fluorescent properties, gives all the appearance of fluorescing in these tubes, and on a little thought the cause of this became clear.

The only fluorescent light that can be seen from the glass of the spiral is that which comes off tangentially, the foreshortening increasing its effect, while from the outer surface, that emitted radially is masked by the bright electric discharge behind.

In passing from the glass to air most of this light will suffer total reflection at the outer surface of the glass, but if water or any other liquid is substituted for the air, its greater refracting power (approaching that of glass) will diminish the above-named action, so that much more of the light will reach the eye. The truth of this explanation was supported by the observation that the nearer the index of refraction in the liquid came to that of glass the brighter was the light seen through it.

This fact renders of no account the observations before made on filtered and diluted solutions of turmeric, but a fresh observation with the spectroscope on tubes free from fluorescence, has fully confirmed my former conclusions as to the true colour of fluorescence in this liquid.

No correction need be applied to the description already published in the case of the asphalt solution, but I may add to what was there stated another striking example.

If one of the little Geissler-tubes containing nitrogen, called spectrum-tubes, be jacketed by means of a perforated cork and a large glass tube, and the jacket filled with pure or non-fluorescent benzine, then illuminating the tube, and with a pipette dropping in that petroleum product called "cosmoline," a lubricating oil made by E. F. Houghton, of Philadelphia, each drop will appear of a rich blue as it dissolves in the benzine, which soon acquires a magnificent blue fluorescence. Increasing, however, the quantity of the cosmoline oil until its colour begins to take effect, the tint of the fluorescence gradually changes to a rich green. By a little care a blue solution may be superposed on a green one in the same tube.

Mr. Houghton informs me that this "cosmoline" is prepared by concentration from crude petroleum at low temperatures by the aid of a vacuum, accompanied by filtration through animal charcoal, by which colour and odour are removed.

Another semi-solid preparation of cosmoline which has a very light colour gives a solution with benzine fluorescing of a magnificent blue.

Returning to the solutions of turmeric, I have found that the fluorescent body in that substance is not its essential oil nor its brown colouring matter, but either the yellow colouring matter itself or something so closely allied to it in solubility that I have thus far been unable to effect any separation.

In connection with this, I am much indebted to Mr. Robert F. Fairthorne, of Philadelphia, who has aided me greatly in the preparation of the various constituents of turmeric in a state of purity.

In my former paper I mentioned that uranium nitrate in solution gave a very faint fluorescence. This appearance, I now find, was due entirely to the above explained action of the tube, and a number of carefully conducted observations now convince me that this substance, while it fluoresces so vividly in the solid state, loses that property entirely when in solution.

DETERMINATION OF COPPER, NICKEL, AND ZINC BY THE BATTERY.

By J. M. MERRICK, S.B.

(Continued from p. 101).

THE amount of zinc contained in the double sulphate of zinc and ammonia was next determined.

The sulphate was made with utmost care, and well crystallised.

The crystals were weighed in the platinum crucible, dissolved in hot water, the solution supersaturated with ammonia, and subjected to the action of a comparatively feeble galvanic current.

If too strong a current be used, the deposit will become flaky or spongy, and very difficult to wash and dry unoxidised. This was the case in the second determination below, which accounts for the comparatively large error.

The deposit of zinc was washed with water first, then with alcohol, and very carefully dried and weighed.

(*l*). 0·5443 grm. ammonio-sulphate of zinc gave 0·088 grm. metallic zinc = 16·16 per cent.

(*m*). 0·815 grm. ammonio-sulphate of zinc gave 0·133 grm. metallic zinc = 16·31 per cent.

In this case, as explained above, the deposit was spongy, and probably oxidised a little.

Theory.	*l.*	*m.*
16·20	16·16	16·31

Some determinations of copper in the purified and re-crystallised sulphate were also made with the following results, viz.:—

(*n*). 0·77 grm. sulphate of copper gave 0·1959 grm. metallic copper = 25·44 per cent.

(*o*). 0·79 grm. sulphate of copper gave 0·2013 grm metallic copper = 25·46 per cent.

Theory.	*n.*	*o.*
25·46	25·44	25·46

The atomic weight of copper is here taken at 31·75.

The following determinations were made with larger amounts of the salts, and in a large platinum dish.

(*p*). 1·0075 grm. double sulphate of nickel and potash gave 0·1334 grm. metallic nickel = 13·24 per cent.

(*q*). 0·39212 grm. double-sulphate of nickel and potash gave 0·5286 grm. metallic nickel = 13·45 per cent.

(This determination may fairly be thrown out, as the battery was allowed to run all night, and the nickel on the edges of the liquid had a chance to oxidise, and thus increase the apparent percentage up to 13·45).

In the following determination the large dish used was counterbalanced to within 2 grms. by platinum crucibles, and abundant time allowed in every weighing for the platinum vessels on each scale to condense the amount of moisture proper to the temperature of the balance case.

The balance used is one of Becker's make, turning readily with 0·0001 grm. when loaded with 55 grms. in each pan; but even this is, I am confident, not delicate enough for the perfectly accurate determination of small quantities of metals by the galvanic method.

(*r*). 1·7857 grms. double phosphate of nickel and potash gave 0·2369 grm. metallic nickel = 13·27 per cent.

Theory.	*p.*	*q.*	*r.*
13·29	13·24	13·45	13·27

It will be observed that in this method of determination the metal is weighed *as such*; that is, we have no assistance in our work from an increased atomic weight, as *e.g.*, when sulphur is determined as sulphate of baryta, and, consequently, the utmost care is required in weighing. In every case, for exact work, the platinum dish should be balanced as near as may be by one of equal size. The metallic deposits should be washed with alcohol, dried very cautiously, and the plated dish allowed to stand on the balance at least ten minutes before its weight is taken. In this way, and by using for the work an only moderate battery power, I believe determinations can be made whose exactness and nicety will depend on the delicacy of the balance employed.

Indeed, I see no reason to doubt that, with a sufficiently delicate balance, the results will not vary much in the third decimal figure, and I believe it is by this process that the atomic weights of copper, nickel, and cobalt will finally be settled.

Laboratory, 59, Broad Street, Boston, Mass., U.S.
August 15, 1871.

CONTRIBUTION TO OUR KNOWLEDGE OF THE COLOURING MATTER CONTAINED IN COCHINEAL.

By C. LIEBERMANN and W. A. VAN DORP.

IN order to judge of the constitution of the colouring matter of cochineal we considered it best first to investigate the nature of the nitrococcic acid, as being the most thoroughly known product of the decomposition of the colouring matter alluded to.

The acid just mentioned is formed by the action of nitric acid upon the colouring matter, while, according to Warren de la Rue, the formula of nitrococcic acid is $C_8H_5(NO_2)_3O_3$. Since this acid, as stated by the author just named, saturates two atoms of basis, it cannot be the nitro-product of one of the isomeric methoxybenzoic acids, but it might be, as suspected by Strecker, derived from a cresotic acid provided the formula (above-mentioned) correctly expresses the molecular size of the acid.

We have found that nitrococcic acid can be obtained readily and in large quantity by employing for its preparation commercial carmine instead of the chemically pure pigment of cochineal, which is difficult to prepare. When finely pulverised, carmine is gradually put into a vessel containing boiling nitric acid (sp. gr. 1·37) as long as the violent evolution of red vapours continues; the whole mass solidifies after evaporation, yielding a mixture of crystals of oxalic and nitrococcic acid, from which the former is removed by re-crystallisation from a very weak nitric acid solution, the latter being obtained in a pure state in the shape of large foliated silvery crystals. On heating the nitrococcic acid along with water to 180° in a sealed tube, there escapes from the latter, when opened after the operation, a considerable quantity of carbonic acid, while at the bottom of the yet warm tube an oily fluid is observed, which, on cooling, solidifies, exhibiting a yellow-coloured crystalline structure; by the aid of water, in which liquid nitrococcic acid is more readily soluble, the newly formed substance is freed from any adhering nitrococcic acid. On further investigation of the yellow-coloured body, it was found to possess the composition of trinitrocresol, $C_7H_4(NO_2)_3OH$, agreeing, as regards its properties, in all respects with the trinitrocresol obtained by Duclos from coal-tar cresol. The trinitrocresol obtained by us, as just mentioned, fuses at 104°, and its potassa salt, $C_7H_4(NO_2)_3OK$, crystallises from an aqueous solution, exhibiting yellow coloured, needle-shaped crystals.

Nitrococcic acid is, consequently, one of the isomeric trinitro-cresotic acids, but, since these have not been hitherto obtained from any of the now-known cresotic acids, it is not possible by comparison to decide from which of these acids it is derived. The dissociation of nitrococcic acid by the action of water takes place according to the following formula:—

$$C_8H_5(NO_2)_3O_3 = C_7H_5(NO_2)_3O + CO_2.$$

The same kind of dissociation takes place when nitrococcic acid is heated along with pure hydrochloric acid to 180°; no substitution of the nitro-group by chlorine takes place.

From the formation of cresol from nitrococcic acid, we conclude that the colouring matter of cochineal contains methyl groups to which remnants of benzol (*benzolreste*) unite. In order to protect that portion of the molecule of carmine which, by the action of nitric acid, becomes nitrococcic acid, from the oxidising and nitrating influence of that acid, we have tried to bring about a dissociation of the pigment by means of concentrated sulphuric acid.

When a solution of carmine in concentrated sulphuric acid is submitted to heat, the yellowish-red colour of that solution changes at 120° into violet, while CO_2 and SO_2 are evolved; the heat having been increased to, and kept for some time at, 140° to 150°, there is, by the addition of water to the acid solution, precipitated another newly formed pigment in the shape of a brown-coloured flocculent substance, which, having been collected on a filter, well washed, and next dried, and then treated with boiling alcohol, leaves, on evaporation of that menstruum, the new body which we term *ruficoccin*, difficultly soluble in cold water, and thereby distinguished from carminic acid and carmine-red, soluble in alcohol, exhibiting a magnificent yellow fluorescence. This substance is, to some extent, sublimable, giving off red fumes, and solidifying in needle-shaped yellowish-red crystals. Previously mordanted textile fabrics are dyed by this pigment similar to cochineal, but the dyes are less brilliant; upon being analysed, the formula of this body was ascertained to be $C_{16}H_{12}O_6$.

Considering the origin and reactions of ruficoccin, and finding these to be very nearly analogous to rufigallic acid and the opianic acid pigment, $C_{14}H_8O_6$, derived from anthracene, we do not doubt that it (the ruficoccin) contains the complex of dimethylanthracen, and that, we think, the constitutional formula of the former mentioned substance is—

$$C_{14}H_2\begin{cases}(CH_3)_2\\(OH)_4\\H\\O_2.\end{cases}$$

The origin of ruficoccin can be readily explained when it is assumed that two molecules of the substance which, by nitration form nitrococcic acid, join with elimination of water.*

$$2\left(\begin{matrix}CH_3\\C_6H_2(OH)_2\\COOH\end{matrix}\right) - 2(H_2O) = C_{14}H_2\begin{cases}(CH_3)_2\\(OH)_4\\H\\O_2\end{cases}$$

The behaviour of ruficoccin with zinc dust confirms our view just expressed, for by the action of that metal ruficoccin yields a hydrocarbon akin to anthracen, which new hydrocarbon fuses at a high temperature, and sublimes, forming a white foliated matter, which combines with picric acid, yielding a red-coloured combination. The hydrocarbon alluded to fuses at 190°, but we have not analysed it as yet, being desirous to obtain it in larger quantity first. The formula found by us for ruficoccin is closely the same as that which Hlasiwetz and Grabowsky have found for coccinin obtained by the dissociation of carmine-red under the influence of fusing caustic potassa; coccinin behaves as a hydrochinon of ruficoccin, since, after its (the coccinin's) spontaneous oxidation by contact with air, it exhibits the same colouring phenomena as ruficoccin does. The fact that by the fusion with caustic potassa the reduction product is formed agrees with the analogous behaviour of anthrachinon; Hlasiwetz and Grabowsky have observed that along with coccinin succinic acid was formed. Although these chemists ascribe the formation of that acid to the decomposition of a glucoside sugar, it is, according to newly-made discoveries by Baeyer† on pigments, and considering the similarity of the cochineal pigment with the pigments contained in some kinds of dye-wood, not quite impossible that carmine-red is either a derivative of succinic acid, or from an acid which, by fusing with caustic potassa, is converted into succinic acid.—*Berichte der Deutschen Chemischen Gesselschafft zu Berlin.*

NOTE ON PURE CARBOLIC ACID.

By Professor CHURCH, M.A.

SINCE 1856 I have occupied myself a good deal with experiments as to the practical hygienic applications of carbolic acid, particularly as to its use in dentistry and in throat affections, and also as regards its employment as a disinfectant. The rank of carbolic acid as a most valuable contribution from chemistry to medicine is so well assured that it is unnecessary to insist upon this point here. Yet there is an objection urged against this substance, which has some apparent force, simply because the best preparations of commerce are so seldom free from a gas-like or naphthalic odour, which, though entirely foreign to carbolic acid itself, has condemned its use in some quarters. About 11 years ago, in preparing pure carbolic acid for the use of a surgeon-dentist to whom I introduced it, I adopted a plan which I shortly afterwards described before the Odontological Society, and to which I have been lately asked to give greater publicity. My plan, which is very simple, is as follows:—

One pound of the best carbolic acid of commerce (I use Calvert's white crystallised acid) is poured into 20 pounds

* The fact that this compound contains 1 atom of oxygen more than the cresotic acid, the mother or parent substance (*Muttersubstanz*) of the nitrococcic acid, is explained by the observation that, by the dissociation of the cochineal pigment by nitric acid, the gap, or breach rather, made by the dissociation is filled by NO_2, while, in the case of the dissociation by sulphuric acid, the breach is filled by OH.

† These will be published in our columns at a future date.

of cold distilled water, taking care not to permit the *whole* of the acid to enter into solution. With a good sample, if after shaking repeatedly at intervals, between two and three ounces of the acid remain at the bottom of the vessel used, this will be a sufficient residue to hold and contain all the impurities. With bad samples, less water must be used or more acid. The aqueous solution should be syphoned off, and filtered if necessary through Swedish paper till perfectly clear; it is then placed in a tall cylinder, and pure powdered common salt added with constant agitation till it no longer dissolves. On standing the greater part of the carbolic acid will be found floating as a yellow oily layer on the top of the saline liquor, and merely requires to be removed by a syphon or pipette to be ready for use. As it contains 5 per cent or more of water, it does not generally crystallise, but it may be made to do so by removing it to a retort, and distilling it from a little lime. The portion collected up to 185° C. or thereabouts has at ordinary temperatures scarcely any odour, save a faint one resembling that of geranium leaves; and I have taken advantage of this curious resemblance still further to mask the slight smell proper to absolutely pure carbolic acid by the addition to it of four drops per fluid ounce of the French oil of geranium. This addition has the further advantage of liquefying the pure crystallised product.

The carbolic acid purified as above has been so highly appreciated by those professional and private persons to whom I have distributed samples, and who were dissatisfied with the purest commercial samples, that I have thought it best to publish my simple plan, for which, however, I claim no originality. It involves, I know, considerable loss of material, but the saline liquor remaining may be distilled and thus made to yield up a second portion of pure carbolic acid, and it will be found a very pleasant and effective domestic disinfectant and deodoriser.

When dissolved in 230 parts of water and used as a gargle, or in 25 parts for painting the throat, or in 50 parts for a carbolic spray, the pure acid is rarely, if ever, objected to even by the most fastidious person. Of course it may be readily mingled with olive or other oil (1 : 25) or with glycerine, for dressing cuts and sores, and when introduced into the little air-purifier invented by me and noticed in your columns some months back, diffuses wholesome and inoffensive vapour in any place where there are disagreeable effluvia of vegetable or animal origin.

THE GASES FROM THE BESSEMER CONVERTER.

By W. MATTIEU WILLIAMS, F.C.S.

MR. SNELUS, in his paper printed in the last number of the CHEMICAL NEWS, disputed my supposition that the brilliancy and whiteness of the Bessemer flame, especially in its latter stages, may be partially due to the combustion of hydrocarbons, the basis of his conclusion being that he does not find any hydrocarbons by the means he has adopted for collecting the gases.

I never supposed that he would find any hydrocarbons there, for the simple reason that they must be oxidised before they reach the mouth of his collecting tube. He might as well dispute the combustion of carbon because he finds no uncombined carbon in the same place. If I am right, he should find not hydrocarbons, but the products of hydrocarbon combustion, viz., carbonic acid, carbonic oxide, and *water*. He has looked for and found the two former, but has altogether omitted the consideration of the water.

In consequence of this omission, his investigations throw no new light upon this question, but leave it exactly where he found it. He does not tell us whether any deposition of moisture could be obtained by cooling down his sealed collecting tubes, or anything else concerning the hygrometric condition of the gases they contained. All the analyses stated by Mr. Snelus make up exactly the 100 parts without any loss. Did he dry his gases before making these analyses, and if so, how much did they lose in drying? If they were dry already, what became of the water originally contained in the atmospheric air used for the blast?

In asking these questions I am not finding fault with what Mr. Snelus has done, but, on the contrary, regard his work as an important contribution to our knowledge on this subject. My object is simply to show that further investigations are necessary before the question which I raised respecting the hydrocarbons can be answered either way.

My reasons for suspecting that hydrocarbons are burning in the Bessemer flame are—that the so-called "carbon spectrum" which it exhibits is far more complex than the carbon spectrum proper; that the colour and general appearance of the flame is quite different from that produced by the combustion of simple carbon or carbonic oxide under such circumstances; that the spectrum is more like a hydrocarbon than a simple carbon spectrum; that the flame presents exactly the appearances we can obtain by artificially mixing carbonic oxide and hydrocarbon (coal-gas for example) in certain proportions; and, further, that in the Bessemer converter during the blow we have the materials and conditions which, theoretically, should produce such an admixture of hydrocarbon and carbonic oxide.

I protested against the looseness of describing the Bessemer spectrum as a "carbon spectrum" on the ground that each compound of carbon affords its own special spectrum, and that the Bessemer spectrum is one of these compound spectra, and I directed the attention of spectroscopists to the interesting practical questions relative to the state in which carbon exists in steel which the study of the Bessemer spectrum might help to solve if it could reveal the composition of the Bessemer flame. My paper was written before Dr. Watts's recent investigation on this subject were published. These have, in a great measure, removed the objections I made to the previous spectroscopic investigations of the Bessemer flame.

In examining this subject we must always remember that we are not dealing with an ordinary hollow flame supplied with oxygen from outside. From such a flame we might, by the method adopted by Mr. Snelus, obtain the *combustible* gases. The Bessemer flame is quite different. It is supplied by forcing air through *solid* combustibles, some of which yield gaseous *combustion products*. Mr. Snelus can only thus obtain the gaseous products of combustion by his method, and even though he had looked for water and found it among them, the question of whether hydrocarbons were burning would still remain unanswered. If, however, the spectroscopist can succeed in identifying the characteristic spectrum of the Bessemer flame with that of any particular hydrocarbon, or nitrocarbon such as cyanogen, or a mixture of cyanogen and hydrocarbon, he may throw some light on the much debated question of whether steel is a compound of simply iron and carbon, or iron and a hydrocarbon, and why it is that cyanides and other nitrocarbon compounds are so effective in steel making.

Woodside, Croydon,
Oct. 7, 1871.

NICKEL PLATING AS APPLIED TO PHOTOGRAPHIC PURPOSES.

By JOHN SPILLER, F.C.S.

ABOUT ten years ago, when visiting the bank-note printing establishment of Messrs. Bradbury and Wilkinson, in Fetter Lane, I was shown some nickel-coated plates from which the "nature printing" specimens had been prepared, and had an opportunity of seeing the electro-deposition

of pure nickel upon copper and other metals practically carried out as one of the branches of their printing operations. This process was being applied conjointly with, or as a substitute for, the method of steel facing (*acierage*) of which they are the patentees, and it struck me at once that the permanent quality of the nickel deposit so formed was capable of wider application, and might serve as a means of protecting steel objects from the rusting influence of damp air.

At my suggestion a few steel articles—particularly a dinner-knife, spatula, and split-ring—were coated with nickel, in order to test the degree of protection which such a process would offer when applied to swords, bayonets, helmets, breast-plates, spurs, harness chains, and steel accoutrements generally. The experiment proved perfectly successful, and without prejudice to the colour, and steps were then taken with the view of submitting the idea to the notice of the War Office authorities, particularly as the cost of applying such a process did not appear likely to stand in the way of its general adoption when the great saving of time in cleaning these articles was duly taken into account.

Beyond establishing the fact, no immediate result followed, and from that time to the present year the application of electro-deposited nickel has, so far as I am aware, been restricted to the specific purposes for which Messrs. Bradbury and Wilkinson have continued to apply it in their establishment. Within the last two or three years fresh attempts in my original direction have led to the employment of this process in America, where a patent was taken out for the application, and a company now working under a licence of the American patentees has recently commenced operations in London and Birmingham. I am indebted to the energetic manager of the Plating Company (Limited), Mr. Channer, of 34, Kirby Street, Hatton Garden, for the opportunity of inspecting a vast collection of objects to which the nickel-coating has been applied, and have been furnished likewise with small specimens of copper, brass, and steel coated with the metal in question, by which I am enabled to substantiate the statements made in their prospectus relative to the wonderful degree of protection afforded to the underlying metals by the superficial deposit of pure nickel. I have since had my regulation sword coated at their works, and find it now perfectly secured against rusting in wet weather, and so easily kept in condition that the blade and scabbard require only to be wiped with a washleather, instead of undergoing the tedious process of burnishing, to fit it for appearance on parade.

A small square bar of steel similarly coated has been repeatedly immersed in water for hours together without showing any signs of rusting, and I find it possible to bury it in flowers of sulphur for several days without tarnishing the lustre of the nickel surface. Neither has this latter severe test any effect upon the copper and brass bars upon which the nickel coating has been applied, and these metals may even be immersed in an aqueous solution of nitrate of silver without effecting the reduction of that metal. In one of the angles only, where the coating seems to be imperfect, was there any indication of silver reduction in the case of the brass tube, the steel bar being perfectly protected over the whole surface against the action of silver and copper solutions. Here, then, is a valuable property which I was not led to anticipate in the case of electro-deposited nickel, for I could not have predicted from my chemical knowledge that a metal of the zinc and iron group would be proof against the action of nitrate of silver; but the experiment proves it to be so, and we must regard pure nickel as belonging (from this point of view) to the class of noble metals, resisting, like gold and platinum, the attack of sulphur and of highly corrosive metallic solutions.

The nickel facing when burnished has a whiter colour than polished steel, although not equal to silver itself, its aspect being rather that of rolled platinum. A chemist to whom I showed the specimens pronounced them at once to be very similar to platinum in regard to colour, thus confirming my own impression on this head. It withstands the action of heat also remarkably well, for the fusion-point is very high, and oxidation occurs only at elevated temperatures. With the view of testing its general applicability to laboratory work I am having a brass scale-pan coated with nickel, and will report later as to its success. For fine balance beams and weights, lens mountings, reflectors, laboratory microscopes, Sykes's hydrometers, still worms, egg beaters, camera fittings, and a variety of apparatus used by the chemist and photographer, the nickel coating will probably find extensive application; and I have seen some oval picture-frames of very pretty effect made from stamped brass coated with nickel. It remains to be mentioned that burnished and matt surfaces of this metal may be used in combination for ornamental purposes.—*The Photographic News.*

ON THE DETERMINATION OF MOLYBDIC ACID AS PLUMBIC MOLYBDATE.

By THOMAS M. CHATARD.

GREAT difficulty has always been experienced in determining molybdenum by any of the methods generally in use. The precipitation as mercurous molybdate, and the subsequent treatment, are both tedious and unsatisfactory, and an accurate determination as sulphide is almost impossible, the filtrate remaining blue even after repeatedly passing sulphydric acid and filtering.

The following method will, I hope, be found to give satisfaction, both as to ease of working and accuracy of results.

Add to the boiling solution of the molybdate, plumbic acetate in slight excess. Boil for a few minutes; the precipitate, at first milky, will become granular and will subside easily, leaving a perfectly clear supernatant liquid. Care must be taken in boiling, as the thick milky fluid is very apt to boil over. A ribbed filter is to be used and the precipitate is to be washed with hot water. The washing proceeds with great ease and thoroughnes, and not the slightest milkiness should be apparent in the filtrate. The precipitate is dried at 100°, separated from the filter and ignited in a porcelain crucible.

The results were as follows:—

Grms.		Grms.		Per cent.
1·0744	Na_2MoO_4 gave	1·9176	$PbMoO_4$	= 46·64 Mo.
1·4440	,, ,,	2·5738	,,	= 46·60 ,,
1·2221	,, ,,	2·1811	,,	= 46·66 ,,
1·2871	,, ,,	2·2999	,,	= 46·74 ,,

Mean = 46·66.

The theoretical percentage of Mo in Na_2MoO_4 is 46·60 if Mo = 96, this being the number given by the most recent determinations.

The process seems therefore to give very good quantitative results, and is both easy and expeditious. The precipitated molybdate separates easily from the filter and can be heated to low redness without decomposition.

Analogy would seem to offer a good method for tungstic acid, and experimental analyses were made for this purpose, but after repeated trials the process was finally abandoned, as the precipitate came down so finely divided that it passed through the filter. The precipitation seems, however, to be complete, and I have hopes that with closer filter paper greater success will be obtained.

Attempts were made to determine arsenic as arsenate of lead, but without good quantitative results. On the other hand, I tried to determine lead as molybdate, tungstate, and arsenate, but without success, as the presence of an excess of the precipitant in such cases seems to exert an injurious effect, the filtrate or washings speedily becoming cloudy.

It may not be out of place to mention some work upon molybdenum undertaken some time ago, which, though unsuccessful, is not without interest. Various methods were devised of weighing the molybdenum as sulphide.

One way was to precipitate molybdic acid as mercurous molybdate in the usual manner. The suspended molybdate was boiled and sulphydric acid passed into the boiling liquid.

The mercurous molybdate was decomposed and mercurous sulphide and molybdic sulphide were the results. The sulphides were thrown upon a filter and washed with cold sulphydric acid water, dried and ignited in a current of sulphydric acid, but this process failed to give satisfactory results.

Again, sodic molybdic was heated with four parts of dry sodic hyposulphite till all the free sulphur was driven off, leaving, according to theory, $Na_2SO_4 + MoS_3$. The mass was then digested with hot water, filtered and treated as before. When any of the sulphur was left, it was found that some of the molybdenum went into solution as sulphomolybdate of sodium. Even after adopting every precaution, enough was still dissolved to vitiate the analysis: —*American Journal of Science.*

ON THREE MASSES OF METEORIC IRON FROM AUGUSTA CO., VIRGINIA.*

By J. W. MALLET,
Professor of Analytical and Applied Chemistry, University of Virginia.

Nearly two years ago I learned that a lump of iron, which from the description given of it I supposed to be meteoric, had been turned up by the plough in Augusta Co. in this State, and soon afterwards I obtained possession of this specimen by the kind assistance of Hon. J. B. Baldwin, of Staunton. It proved to be beyond question a meteorite, weighing about 56 lbs.

A few months later, I saw at the Annual Fair of the State Agricultural Society in Richmond, a second mass, of smaller size, weighing about 36 lbs., which had come from the same county, and was exhibited along with some iron ores by Major J. Hotchkiss, of Staunton. Learning from me that I was about to examine and analyse my own specimen, and was anxious to compare it with the other found in the same part of the country, Major Hotchkiss was obliging enough to lend me the latter, and to permit me to cut off enough for analysis.

Quite recently he has placed in my hands a third specimen — also from Augusta Co. — weighing but about 3¼ lbs.

I shall speak of these three masses as No. 1, No. 2, and No. 3, in the order in which they are mentioned above; No. 1 being my own specimen, and Nos. 2 and 3 those of Major Hotchkiss.

All three present quite the same general appearance. They are of a very irregular pear shape, one end of each mass being larger and more rounded than the other—the smaller end of each is somewhat flattened, but by concave surfaces, in one direction. No 1 was more massive and rounded than the others—No. 2 most flattened—the latter had some rude resemblance in shape to a shoulder of mutton. The dimensions of the masses before cutting were as follows:—

	No. 1. Centimetres.	No. 2. C.m.	No. 3. C.m.
Maximum length	28	27	11
,, width, at large end ..	21	10	9
,, ,, at small end ..	17	19	5
,, thickness, at large end	13	13	8
,, ,, at small end	11	5	3

The exact weights before cutting were:—

No. 1.	No 2.	No. 3.
25,429 grms.	16,441 grms.	1644 grms.

the masses being entire, nothing having been previously detached from any one of them.

The surface of each of the masses is rough and irregular. At some points, which have been rubbed, the iron exhibits its metallic lustre, and traces of its crystalline character may be observed, but nearly the whole surface is covered with a dark brown crust, consisting essentially of hydrated ferric oxide, which varies from about an eighth to a third of an inch in thickness. This crust is hard, and pretty firmly adherent. On exposure to moist air a rusty liquid exudes in drops from numerous points upon the surface, and in this watery liquid chlorine, iron (chiefly as ferrous chloride), and nickel were detected. The masses are of course magnetic, and on examination give evidence of feeble magnetic polarity, with multiple poles.

The union of hardness and toughness in the iron makes it quite difficult to cut, and in attempting to obtain with the planing machine a slice of considerable size the ordinary cutting tools were blunted and broken; it was found necessary to drill a row of holes and connect these by a cut made with the planer.

The specific gravity was taken for Nos. 1 and 2 with solid pieces of about 140 grms. and 95 grms. respectively, cut from the interior of the masses, and for No. 3 with about ten grms. of clean shavings (from the planer) in a specific gravity bottle.

The results were:—

	No. 1.	No 2.	No. 3.
Specific gravity, at 15° C.	7·853	7·855	7·839

The interior structure of the iron is compact and highly crystalline, of much the same general character throughout, but a few small grains and streaks of a brownish yellow mineral were noticed, which on being picked out and examined proved to be troilite. They are, however, minute fissures running through several portions of the metal.

Traces of the Widmannstättian figures may be detected upon a polished surface even without the aid of an acid, and when the iron has been etched by nitric acid the markings are exceedingly distinct and beautiful, fully as much so as in any specimen of meteoric iron I have ever seen. The general appearance is a good deal like that of the iron from Lenarto in Hungary, and some of the Mexican specimens. In the mass No. 1, upon the principal cut surface, narrow, well-defined bands of alternate nickel-iron and Schreibersite are parallel or intersect each other at angles of about 60° and 120°; in the figures on the principal surface of No. 2, the angles of intersection more nearly approach 90°; on the much smaller cut surface of No. 3, the figures are somewhat more irregular, but the angles approach 60°. By etching surfaces obtained in other planes it was rendered evident that the difference of appearance is merely due to looking at different projections of the same crystalline structure.

The metal soon rusts upon cut surfaces, especially where the exudation of chlorine occurs, and this renders more distinctly visible the slight fissures which penetrate the interior.

The iron is not passive, though very easily rendered so by nitric acid. It reduces copper rather slowly from the sulphate, and if the whole surface be covered by the latter metal and then washed under a stream of water, rubbing hard with the hand or a cloth, a part of the copper comes off very easily, leaving the remainder firmly attached and reproducing very beautifully the Widmannstättian figures, obviously a case of galvanic deposition, the Schreibersite being the electro-negative solid and receiving the coating of copper.

By the prolonged action of acid delicate white laminæ of Schreibersite are brought into view, which if com-

* From the *American Journal of Science and Arts*, vol ii., July, 1871.

pletely detached are found to be flexible and strongly magnetic.

The following are the results of chemical analysis :—

	No. 1.	No. 2.	No. 3.
Iron	88·706	88·365	89·007
Nickel	10·163	10·242	9·964
Cobalt	0·396	0·428	0·387
Copper	0·003	0·004	0·003
Tin	0·002	0·002	0·003
Manganese	trace	—	trace
Phosphorus	0·341	0·362	0·375
Sulphur	0·019	0·008	0·026
Chlorine	0·003	0·002	0·004
Carbon	0·172	0·185	0·122
Silica	0·067	0·061	0·056
	99·872	99·659	99·947

These numbers are so closely accordant that there can be no doubt of the masses being essentially identical in chemical composition.

The nickel and iron were separated, in a cold and quite dilute solution, by means of carbonate of baryta, and the precipitates obtained were carefully tested as to purity before the weights were finally accepted as correct.

Considerable quantities of material were used for the determination of the minor constituents. Particular attention was given to the identification of the minute quantity of tin present, as Professor J. Lawrence Smith has lately mentioned* the fact, that he has never found this metal in the course of numerous analyses of meteoric iron. The precipitate with sulphuretted hydrogen, which contained the tin and copper, was in each case obtained from a solution of more than a hundred grms. of the iron.

I feel satisfied that the chlorine is not of meteoric origin —not an essential constituent of the original masses— but has been derived from the soil in which the iron has lain imbedded. The exudation of watery drops containing metallic chlorides is observable only at points on the outside and on cut surfaces along the lines of fissures communicating with the outside. Although chlorine is mentioned above as found in the general analyses of the planing machine shavings, I failed altogether to detect it in a specially selected solid piece of some 50 grms. taken from a part of No. 1 destitute of fissures or flaws.

The siliceous residue is set down as silicic acid, but some of it seems to have in reality existed as silicide of iron. A part of this residue having been examined with the blowpipe to identify it as silicic acid, another portion was looked at with a magnifying power of 250 to 500 diameters, and in polarised light was seen to consist of an amorphous powder, and rounded, transparent grains of very small dimensions, for the most part from 0·0025 to 0·0100 millimetre in diameter, of well-marked doubly refracting character.

It seems in the highest degree probable that these three masses of meteoric iron represent portions of a single fall from the heavens, agreeing so closely as they do in external character and appearance, in density and internal structure, and in chemical constitution; having, moreover, all been found at but short distances from each other. The precise localities from which they came are as follows:—

No 1, from a spot on the land of Mr. Robert Van Lear, about five miles (a little east of) north from Staunton, in 38° 14′ N. lat. and 79° 10′ W. long.

No. 2, from the land of Mr. M. Fackler, about one mile to the south-east of the locality of No. 1.

No 3, about half a mile still further south-east, or rather a little north of a N.W. and S.E. line passing through the last-named locality.

It will be interesting to watch for the possible detection of other masses in the same neighbourhood.

* *Am. Jour. Sci.*, II., xlix., 333, (May, 1870).

This makes the fourth recorded instance of meteorites found within the State of Virginia, the three preceding having been :—

1. Meteoric stone, which fell in Chesterfield Co., June 4th, 1828, (*Am. Journ. Sci.*, I., xv., 195, and xvi., 191).

2. Meteoric iron, found in Grayson Co., described by Professor Rogers of this University in 1852, (*Am. Journ. Sci.*, I., xliii., 169.

3. Meteoric iron, found in Roanoke Co., and described by Professor Rogers in 1842 (*Am. Journ. Sci.*, I., xliii., 169).

ON THE

CHANGE OF COLOUR PRODUCED IN CERTAIN CHEMICAL COMPOUNDS BY HEAT.*

By Professor EDWIN J. HOUSTON,
Of the Central High-School of Philadelphia.

At a meeting of the Optical Section of the Franklin Institute, held April 26th, 1871, Dr. Wm. H. Wahl exhibited specimens of the double iodides of mercury with copper and silver, discovered by Meusel.† The colour of each of these salts is changed in a remarkable manner by the action of obscure heat rays. The author, in connection with Mr. Elihu Thomson, of the Central High School, was led to undertake an extended series of experiments, with a view of ascertaining the law by which these peculiar changes are governed. The author desires to state that Mr. Thomson's share of the investigations was equal to his own.

Familiar changes of a similar though less striking nature at once suggested themselves, among the most prominent of which might be mentioned the darkening of the red protoxide of mercury in the preparation of oxygen.

The experiments were conducted as follows :—

The substances were placed in the state of dry powders on strips of sheet copper, and heated by means of an ordinary Bunsen burner.

It soon became evident that quite a number of compounds underwent a change of colour when so exposed. The colours observed, however, together with those already known, appeared at first to present facts of the most discordant nature.

In some cases the colours were changed so as to approach the violet end of the spectrum, while in others they approached the red end. To avoid all sources of error, the conditions of the original experiment were carefully considered. Briefly they are as follows :—

1. A certain colour presented by the compound at ordinary temperatures.

2. A decided change of colour, on the application of obscure heat rays.

3. A complete return of the original colour on the removal of the heat, and the cooling of the body to its former temperature.

Bodies not presenting all these phenomena were rejected.

The largest class of bodies that was excluded by this method was that in which a permanent change of colour was produced by heat. In this case the change is caused either by the heat being raised to a temperature sufficient to cause a decomposition of the body, by a change from the amorphous to the crystalline state, by a partial sublimation and subsequent deposition of the sublimate, by a change in the crystalline form, or by some other permanent change in the arrangement of the molecules.

Changes in colour produced by dehydration were also rejected, as, for instance, in the case of the chloride of

* From advance-sheets of the *Journal of the Franklin Institute*. Communicated by Dr. W. H. Wahl.

† *Ber. d. Deutsch. Chem. Gesell.*, iii., 123. *Jr. für Prak. Chem.*, II., ii., 136.

cobalt, which, when hydrated, is a pale pink, but when anhydrous, a deep blue. Hydrous and anhydrous salts are distinct chemical compounds, and have therefore a different molecular arrangement. A class of cases of a somewhat similar nature was also rejected. Here the change of colour was produced by a loss of the water of crystallisation, as, for instance, the sulphate of copper, which changes from a deep blue to a white.

After these sources of error were removed and quite a number of bodies discovered presenting phenomena fulfilling all the requirements of the original experiment, the law became evident. *In every case the colour in its change approached the red or heat end of the spectrum.* Not a single exception to this law was observed.

Before stating the explanation of the way in which these changes are produced, a few words in reference to the relation existing between light and heat may be necessary. That light and heat are produced by a vibratory motion of the molecules of bodies, and that they differ from each other, merely in the rapidity of the vibrations of these molecules, the facts presented by the science of the present day, leaves scarcely room for doubt. A hot body differs from another cooler than itself, not in virtue of any peculiar substance or fluid which it possesses, but simply in the fact that its molecules are in more rapid motion. Increasing the temperature of a body is equivalent to increasing the rapidity of the vibration of its molecules. As the body is made hotter, its molecules vibrate more and more rapidly, until finally a *red heat* is obtained, and light is emitted along with the heat. Now we know that a ray of white light, popularly speaking, is a mixture of seven different kinds of rays, viz., the colours of the solar spectrum. Moreover, we know by actual measurement, that these colours, in the order of the number of vibrations required to produce them, commencing with the least, are as follows: red, orange, yellow, green, blue, indigo, and violet, those of the violet being about twice as rapid as those of the red.

If, then, light differs from heat, merely in the fact that the molecules of a body emitting light are in more rapid motion than those of a body emitting heat, when that rapidity in the vibrations of the molecules of a hot body is reached, that it commences to give out light along with the heat, the colour first emitted should be red, since that colour is produced by the least number of vibrations per seeond, and the colours which successively appear should be orange, yellow, green, blue, indigo, and violet, until finally, these by their intermixture produce white light, and the body becomes *white-hot.* These considerations are fully sustained by the beautiful experiment of Draper, who viewed through a prism the light emitted by a platinum wire heated by a current of dynamical electricity. The colour which first appeared was red, and then successively, orange, yellow, green, blue, indigo, and violet, or more accurately, when the platinum wire became white-hot, it gave a continuous spectrum from the red to the violet.

The boundary between heat and light, then, is found at the extreme end of the red of the spectrum. It is evident that though the range of the spectrum must vary with the sensibility of the eye of the observer—that is, that the heat vibrations will become light vibrations sooner to some eyes than to others—yet in all cases the colour first observed will not be a pure red, but a dark brown; a colour produced by the mixture of black, or the absence of colour with the few red rays first emitted.

It should be borne in mind that the arrangement of the spectrum into seven colours is merely a matter of convenience. In point of fact there is an almost infinite variety of tints. The red, for instance, is merely taken at the mean of the dark red and the orange-reds, and so for the other colours.

Remembering these preliminary considerations a fuller statement of the law of the changes may now be given.

In all cases in which the colour of a body is changed by the application of heat, and the original colour regained on cooling, the nature of the body being in no wise altered, the character of the change is as follows: the addition of heat causes the colour to pass from one of a greater to one of a less number of vibrations; the obstruction of heat from one of less to one of a greater number.

In accordance with this law, violets are changed by heat into indigo violets or indigoes, indigoes into blues, blues into bluish-greens or greens, greens into yellowish-greens or yellows, yellows into orange-yellows or oranges, oranges into orange-reds or reds, and finally reds into brownish-reds or blacks; by cold the inverse order is observed. In many instances substances were noticed that ran down the scale two or more colours; for example, the green iodide of mercury, which passes from yellowish-green through the yellow, and orange to the red.

Among the most sensitive substances noticed are the following, arranged by their colours in the order of the spectrum.

REDS.—*Ferrocyanide of Copper.*—Colour at ordinary temperature, mahogany-brown; darkens by heat to brownish-black, original colour returning slowly on cooling.

Brown-Red Sulphide of Antimony—Kermes mineral.—Colour brownish-red; changes to darker brownish-red.

Anhydrous Sesquioxide of Iron.—Colour, brownish-red; changes to dark red, brown, brownish-black and black at a temperature greatly below a red heat.

Subiodide of Copper.—Colour, dark red. The changes presented by this substance are very remarkable. On the application of quite a low heat it changes to darker red, and afterwards to a brownish-red, brown, brownish-black, and finally almost a black. The return to its original colour on cooling is rapid.

Protosulphide of Mercury—Vermillion.—Colour, bright red, or vermillion; darkens to brownish-red.

Subchromate of Lead.—Colour, red; changes quite readily to dark red and brownish-red.

Red Oxide of Lead—Red Lead.—Colour, red; changes readily to dark red.

Bichromate of Potassa.—Colour, red; changes to dark red. The change in this case is best observed by heating a small crystal of the salt.

ORANGES.—*Bisulphide of Arsenic.—Realgar.*—Colour, when pulverised, orange-red; changes to red, dark red, and brown; returns readily.

Protoxide of Mercury—Red Precipitate.—Colour, orange-red; changes to red, dark red, and brownish-red.

Iodide of Lead.—Colour, orange; changes to darker orange, orange-red, and red.

Oxalate of the Protoxide of Iron.—Colour, light orange; darkens. In this case the heat must be quite low, as the substance is readily decomposed.

YELLOWS.—*Chromate of Lead.*—Colour, yellowish orange; changes to orange, orange-red, and deep orange-red.

Subsulphate of Mercury—Turpith Mineral.—Colour, yellow; changes to orange-yellow, orange, and orange-red.

Chromate of Baryta.—Colour, yellow; changes to orange-yellow.

Bisulphide of Tin—Mosaic Gold.—Colour, brownish orange-yellow; changes to a dark red very nearly approaching a black; quite sensitive.

Tersulphide of Arsenic—Yellow Orpiment.—Colour, orange-yellow; changes to deep orange-yellow, yellow, orange-red, and red.

GREENS.—*Subiodide of Silver.*—Colour, greenish-yellow; very sensitive; changes first to an orange-yellow, and then to a deep orange.

Subiodide of Mercury—Green Iodide.—Colour, yellowish-green; more sensitive than the preceeding; changes to a yellowish-green, and then successively to an orange-green, reddish-orange, red, and brownish-red. These changes succeed each other very rapidly. They may be best observed by heating at once up to the brownish-red,

and noting the changes of colour that occur as the body cools.

In all the above cases the original colour is fully regained on cooling.

The substances named are by no means all that have been observed to come under the law. Quite a number of other compounds have been noticed; but none of them are as sensitive as those already mentioned. In no case, however, has any compound been found of the colour of blue, indigo, or violet, that, in the solid state, undergoes any decided change whatever, on the application of a temperature short of that producing either a decomposition or a permanent change in the arrangement of its molecules. Nor is this fact contrary to what might be expected. Near the heat end of the spectrum, where the difference between the light and heat vibrations is not so great, we might reasonably expect the particles of a solid to be influenced by each, and to accept a motion which should be a mean of the two, but when we get as far in the spectrum as the blue or indigo, the greatest heat that we can intermingle with the blue or indigo, even if pushed to the point of incandescence, would be but dull red. Now long before this temperature is reached most bodies would undergo decomposition, and were this not the case, even then we could hardly expect the particles of a solid, trammelled as they are in their freedom of motion by the force of cohesion, to accept a mean of two kinds of vibrations, which differ so greatly in their wave lengths. Still it must be borne in mind that solids differ very greatly from each other in the freedom of motion of their molecules, and it is not improbable that a number of solids as high in the scale of colour as the blues, indigoes, or violets, may eventually be found conforming to the law.

A few very significant facts were noticed in this connection in the case of two pure white substances, viz., the oxides of zinc and of tin; their behaviour is as follows:—

Oxide of Zinc—Nihil Album.—Colour, white; changes on the application of heat to a scarcely perceptible bluish-white, green, and yellowish-green. Does not entirely return on cooling, though it resumes nearly its original colour.

Oxide of Tin.—Colour, white; here the range is more remarkable. It changes first to a pale green, then to a decided yellowish-green, and even runs as far down the scale as orange and reddish-orange; returns on cooling to a greenish-white.

These two substances have not been included in the regular list of solids, as they fall somewhat short of the conditions of the original experiment. They conform sufficiently to it, however, to call attention to their behaviour.

Experiments were also made on solutions of various solids. As a general rule, it has been found that a substance in solution is more sensitive to the action of heat than when in the solid state. This, indeed, should be so, as the action of the solvent is simply, by its adhesion for the solid, to separate it into very small particles and to give them much greater freedom of motion. Solids in solution have been found as high in the scale as the violet, which conform perfectly to the law.

These experiments were conducted as follows:—

The solution was made of the required strength and then divided between two thin glass test-tubes, of the same size and thickness. They were then held, side by side, between the eye and the light, and carefully compared by transmitted light. If any difference in tint was observed, the solutions were poured together and again thoroughly mixed. If any difference still existed on again dividing them between the two test-tubes, one of the tubes was rejected as differing in thickness or colour from the other, and replaced by another until exactly the same tint was obtained. It will readily be seen that these precautions were necessary, in order that the results obtained should not be equivocal. One of the solutions was heated in a Bunsen burner, and the change carefully noted by comparison from time to time. Of course the highest temperature was limited to the boiling-point of the solution under the pressure of the atmosphere. In many cases, however, decided changes were observed long before even this point was reached. No experiments were tried on temperatures obtained by boiling under high pressures in confined glass vessels, though there is every reason to believe that by these means splendid results would be obtained. It is purposed, if time allows, to pursue the investigation in this direction at some future day.

Of course, in all cases where the colour did not entirely re-appear on cooling, the experiment was rejected.

The solvent used was water. As the colour of a solid in solution varies with the strength of the solution, it will be understood that in all cases the amount of solid dissolved was that requisite to produce the tint described.

The following are amongst the most sensitive substances noticed:—

REDS.—*Rose Aniline.*—Solution of a strength sufficient to produce a decided red; darkens perceptibly on the application of a boiling heat.

Decoction of Logwood.—Solution of a deep red; darkens on the application of heat.

Chloride of Cobalt.—Colour of solution, pinkish-red; changes to a darker pinkish-red.

Sesquisulphate of Iron.—Colour of solution, light red; changes to brownish-red.

ORANGES.—*Chromic Acid.*—Colour of solution, reddish-orange; changes to an orange mixed with a greater amount of red.

Bichromate of Ammonia.—Colour of solution, orange-red; changes to a pure red.

Sesquichloride of Iron.—Colour of a weak solution, orange-red; very sensitive; changes to red and brownish-red.

Bichromate of Potassa.—Solution of an orange-red; changes to a red.

YELLOWS.—*Sesquinitrate of Iron.*—Colour of solution, brownish-yellow; changes to brownish-red.

GREENS.—*Ferrocyanide of Potassium.*—Solution of a yellowish-green; changes to a yellow.

Chromate of Potassa.—Solution of a yellowish-green; changes to a yellow.

Nitrate of Nickel.—Solution, pale green; changes to pale yellowish-green.

Sulphate of Nickel.—Solution, green; changes to yellowish-green.

BLUES.—*Chloride of Copper.*—Colour of weak solution, bluish-green; changes to a very decided yellowish-green. This substance is quite sensitive, the colour returning rapidly on cooling.

Sulphate of Copper.—Solution of a decided blue; changes to a very decided green at the boiling-point of the solution. Returns to its original colour rapidly on removal from the heat.

VIOLETS.—*Ammonio-Oxide of Nickel.*—Solution of a violet-blue; changes to a light blue; returns fully on cooling, and cannot therefore be attributed to any loss of ammonia.

Solution of Litmus.—Colour, violet; changes to an indigo-blue.

It may be objected that the substances noticed do not present as great a range of changes as those observed in solids. It must be remembered, however, that the temperature in no case differed much from the ordinary temperature, being never much greater than 220° F., while in the experiments with solids the temperature was often more than three times as great. We feel sure that experiments with liquids at higher boiling-points will show substances running down the scale much further than the observed solids.

The Action of Cold.—It would appear from the law already stated, that the colour of a body is affected by its temperature, and that in proportion as this temperature is

raised, the colour is lowered; moreover, considering the colour emitted by the body at its higher temperature, the colour is always raised in the spectrum as the body cools. For example, take the case of the green iodide of mercury, which, as before mentioned, is yellowish-green at ordinary temperatures. By the action of heat, its colour is successively lowered through the yellow, orange, and red, which latter is reached at the maximum temperature of exposure. Cool the body from this point, and its colour will become orange, yellow, and yellowish-green, respectively.

Now, the same reasoning that applies to the cooling of the body from this higher temperature should also apply, though not with equal force, to its cooling from any temperature, such, for instance, as that of the place in which the body is situated. The colour emitted by a body at any temperature is always lower than it would be were it not for the intermingling of the heat vibrations. Remove it as much as possible from the influence of these vibrations, or, in other words, cool it, and the emitted light must be of a higher pitch of colour. It would appear then, that as the effect of raising the temperature of a body above its ordinary temperature is to lower the pitch of the emitted light, so cooling it below that temperature must be to raise the pitch. The raising, however, would hardly be as great, proportionally, as the lowering. As we recede from the boundary of the heat and light vibrations, we lessen the chance of their producing by intermingling a resulting mean vibration.

With a view of testing the truth of these theoretical considerations, experiments on the action of cold on substances in both the solid and liquid condition were made.

(To be continued).

CORRESPONDENCE.

THE AMMONIA PROCESS.

To the Editor of the Chemical News.

Sir,—In your issue of 7th July, there appeared a letter from Mr. Wanklyn on the success of his ammonia process; he concludes by saying that the sanitary officers of the Indian Government have adopted it. This is correct, but I am sorry to say that they adopted it rather too hastily, and that the results of the process, as far as has been published, say little in its favour. I have had occasion to examine the methods laid down for the analysis of water in India, both by personal experiment and by examination of the published results of the analyses made in Bengal, and as regards the ammonia-process, the results are most unsatisfactory: in the hands of other analysts it has given the wildest quantities imaginable; in my own it has been a complete failure.

Finding that water after water gave no albumenoid ammonia when treated according to Messrs. Wanklyn and Chapman's instructions, I made some test-experiments with water containing natural organic matter, quinine wine, and ammonia. I found that neither carbonate of soda nor the alkaline solution of permanganate evolved any ammonia from a quantity of fresh urine which should have given 2 milligrammes; urine not perfectly fresh would give 0·01 to 0·02 milligramme of ammonia. If before or after the experiment I added ammonia (as sulphate) to the half-litre of water in the retort I could always obtain it; even from 0·05 milligramme I would obtain 0·02 to 0·04 in the distillate.

The alkaline solution of permanganate failed to evolve any ammonia from water to which quinine had been added, or from water containing enough natural vegetable matter to decolourise a standard solution of permanganate nearly as fast as it could be poured in (no nitrites or ferrous salts being present).

Neither do Indian waters, as far as my experience goes, contain anything like the amount of ammonia said to be contained in English waters. I have never yet succeeded in detecting it, except in waters obviously containing sewage in considerable quantity; and when distilling water for laboratory use, I fail to detect ammonia in the first 100 c.c. distilled over from ten litres of ordinary well-water. I may add that my Nessler's solution is not in fault, as I can detect 0·01 milligrammes of ammonia in a distillate.

Edward Nicholson, Asst. Surg. R.A.,
Analyst of Waters, Mysore and Ceder Districts.

Bangalore,
Aug. 18, 1871.

MISCELLANEOUS.

New Appointment.—We are glad to find that Mr. Robert Routledge, who took the first place in honours for chemistry at the final B.Sc. examination of the London University last year, and who at a previous examination took first-class honours in Natural Philosophy, has been appointed conductor of the classes in Chemistry and Physical Science at the Manchester Mechanics' Institution. These classes, which are held in the evening, consist of courses on Applied Mechanics, Steam and the Steam Engine, Acoustics, Light and Heat, Magnetism and Electricity, Inorganic and Practical Chemistry.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, September 11, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Researches on the Origin of the Heat set free when the Motion Imparted to a Disc of Copper is Stopped by the Action of an Electro-Magnet.—P. A. Favre.

Constitution of Luminous Spectra.—Lecoq de Boisbaudran.

Combination of Alcohol with Bases.—Dr. Berthelot.—This lengthy and very valuable memoir is divided into the following sections:—Introduction; alcohols properly so called, viz., ordinary alcohol, $C_4H_6O_2$; glycerine, $C_6H_8O_6$; mannite, $C_{12}H_{14}O_{12}$; gum-phenols, viz., ordinary phenol, $C_{12}H_6O_2$; phenates of soda, potassa, ammonia, lime, and baryta; trinitrated phenol (picric acid)—

$$C_{12}H_3(NO_4)_3O_2;$$

aldehydes; acids of mixed functions (*acides à fonction mixte*); salicylic acid; lactic acid, $C_6H_6O_6$; tartaric acid, $C_8H_6O_{12}$.

Can the Leaves of Plants Absorb Liquid Water?—L. Cailletet.—A very important phyto-physiological memoir.

As usual, this number contains important astronomical, geological, and meteorological papers.

September 18, 1871.

This number opens with the second portion of an important and exhaustive monograph:—

Rocks met with by Perforating the Western Alps between Modane and Bardonnèche.—Elie de Beaumont.—To this paper are added several interesting notes elucidating the origin of the idea of constructing this gigantic work, which was first broached, some thirty years ago, by M. Medail, of Bardonnèche, in a pamphlet published at Lyons.

Thermal Researches on Mixtures.—P. A. Favre.—The continuation of a monograph, portions of which have been published in *Comptes Rendus*, vols. l., li., lix., lxvi., the present being vol. lxxiii. This portion contains a series of tabulated forms exhibiting results of experiments.

Spectra of the Substances belonging to the Nitrogen and Chlorine Class of Elements.—A. Ditte.

Spectra of Selenium and Tellurium.—G. Salet.—The contents of these papers are not suited for useful abstraction.

Thermo-Chemical Researches on Ammoniacal Salts.—Dr. Berthelot.—Since the value of this essay depends chiefly on a series of lengthy formulæ, it is not possible to enter into any details.

Spontaneous Decomposition of Bisulphite of Potassa.—C. Saint-Pierre.—The author relates at length the results of some observations made on solutions of the salt alluded to, kept in closed vessels for several years. From these observations it appears that a solution of bisulphite of potassa becomes spontaneously decomposed, yielding sulphur, sulphuric and thionic acids. The author is engaged with similar experiments on other bisulphites.

On Methyl-Diphenylamine.—C. Bardy.—This paper is entirely written with the view to prove that the discovery of the substance just named, by the reaction of methyl-aniline upon chlorhydrate of aniline, described by C. Girard and G. Vogt (see CHEMICAL NEWS, vol. xxiv., p. 167), had been described some time ago (January, 1870), and published by the author in the *Moniteur Scientifique*, 1870, p. 553, and in *Brevet d'Invention*, No. 88,713.

September 25, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Thermal Researches on the Electrolysis of the Alkaline Bases and Alkaline Sulphates.—P. A. Favre.—The contents of this valuable and lengthy monograph do not admit of any useful abstraction.

Letter from J. Pierre to M. Dumas on the Phenomena Observed by J. Pierre and E. Puchot by the Simultaneous Distillation of Water and of certain Alcohols.—This communication bears upon the subject mentioned in the CHEMICAL NEWS, vol. xxiv., p. 167; but, since the contents of this paper consist mainly of a series of cyphers relating to results obtained, we need not here enter any further into this matter, which will be communicated more fully at a future date by the authors.

Relation Existing between the Spectral Properties Exhibited by the Elements with their Physiological Properties.—F. Papillon.

Researches on the Reciprocal Conversion of the Allotropic States of Phosphorus.—(First part.)—G. Lemoine.—This monograph, elucidated by a series of tabulated forms containing figures relating to results of experiments, contains the record of a most important scientific discovery, and proves, practically, that exact scientific research is reviving rapidly in France. The *resumé* of the labours of this *savant* on the subject in question will be published with the second portion of this paper.

Note on the French and Foreign Malt Liquors Consumed in Paris.—E. Monier.—This paper contains the results of the analysis of twelve different samples of beer, six of which are brewed in France, the rest in other European countries. The sp. gr. of these samples varies from 1·008 to 1·023. The quantity of alcohol, by bulk (c.c. in 1000 grms.), varies from 32·5 (a French brewed beer) to 60·5 (Burton pale ale); glucose, from 4·8 (French beer) to 16·30 (so-called Strasburg beer, but brewed at Paris) grms.; dextrine, albuminoid substances, &c., from 31·0 (French beer) to 58·40 (Munich, Bavarian beer) grms.; salts, from 1·60 (French beer) to 2·80 (Burton pale ale) grms.

New Zinc Paint.—M. Artus.—The author, connected with the Vieille-Montagne Co., exhibits at the meeting of the Academy samples of zinc-white made up with silicate of potassa, and used to paint zinc and other objects. This paint, which resembles stone in aspect, is air-, sun-, and water-proof, and is especially applicable to zinc-covered roofs, but also to plaster, cement, bricks, and other objects. It is also useful for rendering wood, paper, and other readily-inflammable tissues, such as are used, for instance, in theatrical decorations, uninflammable.

Polytechnisches Journal von Dingler, second number for August, 1871.

The following original papers bearing upon chemistry and collateral subjects are published in this number:—

Modified Arrangement of Leclanché's Manganese Galvanic Cell.—M. Boumans.—The description, accompanied by a woodcut, of an important improvement upon the Leclanché galvanic element; it would, however, require the reproduction of the woodcut to make the subject understood.

Studies on the Blast Furnaces Used for the Production of Iron.—C. Schinz.—This portion of the continuation of this exhaustive monograph contains the following sections:—Transmission of heat through the walls of the furnaces; reducibility of the ores; direct and indirect reduction; modulus of charge; causes which accelerate or retard the reduction and carburation of the iron reduction and carburation of the iron.

Question of the Dinas Brick-Making in general.—Dr. C. Bischof.—This paper treats on the conditions to be observed in the making of a peculiar kind of fire-brick, the properties of which are very similar to what in this country is known as Flintshire stone.

Recovering the Nitrous Acid in the Process of Sulphuric Acid Manufacture.—Dr. G. Lunge.—A lengthy essay on this subject, illustrated by several engravings.

Preparation of an Oxidised Aniline-Black Paste, and on an Aniline China Ink.—A. Müller.—20 grms. of chlorate of potassa, 40 grms. of sulphate of copper, 16 grms. of sal-ammoniac, 40 grms. of hydrochlorate of aniline, are dissolved in 500 c.c. of water, and the mixture heated upon a water-bath to 60°. After some two or three minutes, the basin or vessel containing the mixture is removed from the water-bath, because it has a tendency to boil over, in consequence of the strong evolution of vapours of trichloro-nitroform. If it happens that after some two or three hours the thickish magma has not become quite black, it is again heated to 60°. The pasty mass is next left for two days exposed to open air, after which the mass is washed until all the salts soluble in water are removed, and after having become half dry is removed from the filter. The deep coaly-black-coloured paste is either at once thickened with albumen and kept for use (for calico-printing purposes) in tinned iron canisters, or it is dried over sulphuric acid in vacuum, then exhibiting a soft, not glossy, intensely deep black-coloured powder, which, on a preliminary analysis, gave results leading to the formula $C_{84}H_{14}N_8O_{28}$. When the powder is mixed with some gum-water it is an excellent substitute for Indian ink.

Rapid Method of Drying Glue.—Dr. H. Fleck.—This paper treats on a plan of separating, rather than drying, glue from its aqueous solutions by the aid of salts, and gives to glue-boilers a few hints how to apply this method, which yields a glue which is not transparent but turbid.

Gold-like Alloy.—Dr. E. Dingler.—This alloy consists of:—Copper, 58·86; zinc, 40·22; lead, 1·90. It is both inexpensive and durable as well as malleable.

Production of Bismuth in Saxony.—Dr. Wagner.—It appears that this country produces 32,000 lbs. of the metal annually, and that, since bismuth is as yet nowhere produced in any considerable quantity, Saxony rules the market of this article.

Cheap Mode of Preparing Pure Dextrine.—O. Ficinus.—500 parts of potato-starch are mixed with 1500 parts of cold distilled water and 8 parts of pure oxalic acid, and this mixture placed in a suitable vessel on a water-bath, and heated until a small sample tested with iodine solution does not produce the reaction of starch. When this is found to be the case the vessel is immediately removed from the water-bath, and the liquid neutralised with pure carbonate of lime. After having been left standing for a couple of days the liquor is filtered, and the clear filtrate evaporated upon a water-bath until the mass has become quite a paste, which is removed by a spatula, and, having been made into a thin cake, is placed upon paper and further dried in a warm place; 220 parts of pure dextrine are thus obtained.

Journal de Pharmacie et de Chimie, July, 1871.

This number contains the following original papers and memoirs:—

Experimental Researches on the Preparation and Properties of the Chlorides of Propyl and Butyl.—J. Pierre and M. Puchot.—Propylic chloride, C_3H_7Cl, is prepared either by passing gaseous and dry hydrochloric acid into propylic alcohol until no more of the gas is absorbed, and distillation of the mixture thus obtained, or by causing perchloride of phosphorus to act upon pure propylic alcohol, care being taken to apply to the vessel wherein the liquids are contained a cooling mixture, and a peculiar arrangement of the apparatus so as to carry off, without causing inconvenience to the operators, the hydrochloric acid gas which is set free. With due care, 480 grms. of the propylic alcohol yield 180 grms. of the pure chloride, which is a very limpid, colourless, mobile liquid, exhibiting a pleasant sweetish somewhat alliaceous smell, and boils at 46·5°; sp. gr., at 0° = 0·9156. Butylic chloride, C_4H_9Cl, prepared in the same manner as just described, butylic alcohol being of course substituted for the propylic, is also a very limpid, mobile, colourless liquid, boiling at 69°; sp. gr., at 0° = 0·8953.

On Gelatiniform Matter or Albuminose, on Exalbumine, and on Galactine.—A. Morin.—The introduction to this essay gives a review of the labours of Drs. G. J. Mulder, Prevost, Mialhe, Corvisart, Tiedemann, and Gmelin, and on the nitrogenous substances met with in the animal organisms generally referred to as proteine compounds. The main portion of this paper is devoted to the subject of galactine, which term the author desires to be substituted for the other words above mentioned. Galactine, though chiefly met with in milk, is also a constituent of the animal body. The dry residue of the carefully conducted evaporation of milk consists, in round numbers, of:—Caseine, 10 parts; albumen, 1; galactine, 1; butter, 10; milk-sugar, 10; salts, 1; a nitrogenous matter soluble in alcohol, 2 parts. Galactine in fresh state is a somewhat viscous mass, which becomes solid on drying, but remains soft as putty and may be kneaded by the hand into any shape. Galactine is soluble in water, insoluble in ether and alcohol, is not by long boiling with water converted into gelatine, is precipitated like gelatine by tannin, with this characteristic difference that, whereas the precipitate produced by tannin in gelatine is insoluble at a high temperature, the precipitate produced by tannin in a solution of galactine is dissolved at 60°. Galactine, like caseine, has the property of forming emulsions with fatty substances.

Report on the Preparation of Oxygen for Pharmaceutical Purposes.—Dr. Baudrimont.—This very lengthy yet only preliminary paper, illustrated by woodcuts, treats exhaustively on the preparation of the gas alluded to, so as to make it safe and yield a pure gas. The following are the sections:—Action of the heat upon chlorate of potassa; action of the oxides, viz., of copper, peroxide of iron, and manganese, mixed with the chlorate of potassa; chemical action; mode of preparation of oxygen. The author advises:—That the peroxide of manganese should never be used unless previously calcined, whereby, although its composition be modified, it does not lose its useful effect in assisting the ready decomposition of the chlorate potassa; to mix the calcined oxide, in the proportion of equal par

weight with the chlorate of potassa, care being taken to pulverise the last-named substance first; to apply to the vessel containing the mixture as little heat as possible; to test the purity of the chlorate of potassa; and to wash the gas through water; while, lastly, care should be taken to make the tubing required of as large internal diameter as consistent with the size of the retort and quantity of material used at one time, it being preferable not to operate upon too large a quantity of the mixture at a time.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, Nos. 217 and 222 inclusive, January to July, 1871.

This collection, published in one cover owing to events to which it is unnecessary further to allude, contains only the following original essay relating to chemistry:—

Processes in Use at the Dieuze Alkali-Works for the Denaturation and Utilisation of the Residues of Soda and Chlorine Manufacture.—P. Buquet.—This essay, far too lengthy for abstraction, contains the complete account of processes in actual use on the large scale, and so perfect that to the authors, P. Buquet and W. Hofmann, the chemical prize of the society above alluded to was given on July 15, 1870. This essay is divided into the following sections:—Introduction; theory of the question to be solved; oxidation of the char (soda-waste); lixiviation of the char; neutralisation of the acid chloride of manganese; utilisation of the sulphuretted hydrogen; precipitation of the iron; precipitation of the manganese; treatment of the residue; separation of the sulphate and peroxide of manganese from each other; utilisation of the sulphate of manganese for the preparation of nitric acid. An alkali-works, where 20,000 litres of chloride of manganese and 30,000 kilos. of soda-waste are daily obtained, may produce by the process herein briefly alluded to:—Pure sulphur, 1400 kilos.; sulphur as sulphuret, 2200; peroxide of manganese at 60 per cent, 770; hyposulphite of lime, 20; dry sulphate of lime, about 600 kilos.

Revue Universelle des Mines, de la Métallurgie, des Travaux Publics des Sciences et des Arts Appliquées à l'Industrie, May and June, 1871.

The only original paper relating collaterally to chemistry met with in this number is:—

Zinc Metallurgy of the Nouvelle-Montagne Company.—H. Massart.—This memoir, accompanied by a series of engravings, treats very exhaustively on the subject alluded to, entering into all the technical as well as the financial details of the mode of working of this Company, which has its works and mines in Belgium. For all who are interested in zinc metallurgy, this paper contains matter of very great value. The percentage composition of roasted blende is:—ZnO, 53·20; Fe_2O_3, 20·93; CaO, 5·86; PbO, 3·26; SiO_3, 8·15; SO_3, 8·60. Calcined calamine consists, in 100 parts, of:—ZnO, 53·27; Fe_2O_3, 26·42; CaO, 4·68; SiO_3, 16·23. Metallic zinc from blende consists, in 100 parts, of:—Zinc, 98·68; iron, 1·05; lead, 0·25; lime, 0·04. Zinc from calamine contains, in percentages:—Zinc, 99·25; iron, 0·62; lead, 0·13. Refined zinc consists, in 100 parts, of:—Zinc, 99·70; iron, 0·20; lead, 0·10.

Though not strictly belonging to the subjects usually treated of in our pages, we quote the following paper:—

Economic Conditions of the Mines of the Island of Sardinia.—M. Sella.—The copious abstract of an exhaustive report presented to the Committee of Inquiry on this subject, elected by the Chamber of Representatives of the Kingdom of Italy.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, September 14, 1871.

Continuation of the Essay, Studies on the Chemical Dissociation of Bodies.—C. Méne.

Description of Modifications of the Bunsen Gas Burner.—C. Mène.—Illustrated by woodcuts representing various contrivances by which these burners are adapted for different operations.

Analysis of Arable Soil from the Sologne.—F. Masure.—The tabulated results of the estimation of various constituents, nitrogen, phosphoric acid, alkalies, as well as description of the physical and hygroscopic properties of surface-soil and sub-soil of the portion of Central France above-named.

September 21, 1871.

The only original paper in this number is a description, accompanied by woodcuts, of:—

An Electrical Metronome of the Opera at Paris.—J. Duboscq.—It appears that this instrument, belonging to those used for acoustics, is very ingeniously made and answers the purpose perfectly.

September 28, 1871.

Among the original matter contained in this number we notice:—

Distillation of Beet-Root Molasses.—R. Corenwinder.—The gist of this paper bears upon the utility of the addition of sulphuric acid to the molasses, and upon the quantity of that acid required in any special case, which may be ascertained by a volumetrical assay. The author points out that not only the bases present in the molasses have to be saturated but that an excess of acid, sufficient to prevent during the fermentation the formation of organic acids, is absolutely required, because, by the formation of organic acids, less alcohol is obtained, as well as of an inferior quality, because it is contaminated with ethers which cause the alcohol to be bad to the taste and also injurious.

Tabulated Review of the Composition of Fertilising Substances which may be added to Manures, or are fit for use as such by themselves.—C. Mène.—A very useful catalogue, containing the results of analyses, percentically quoted, of such substances as various kinds of wood sawdust, offal from dye-works, glue-boilers, and various substances. This paper is to be continued.

Studies on the Dissociation of Chemical Bodies.—C. Mène.—The continuation of an essay on this subject.

Bibliography.—"M. Georges Ville et ses Engrais Chimiques," par M. Severin Leroy; A. Sagnier, Editeur: Paris, 1871. We call attention to this pamphlet, the contents of which are very well spoken of in this number. Many of our readers will remember that the chemical manures of G. Ville, and his agricultural experiments, have given rise to a great deal of polemic. The French pamphlet here alluded to contains, judging from what is said about it, a thoroughly disinterested review of the whole subject.

NOTES AND QUERIES.

Cement to Resist Sulphuric Acid.—Can any of your readers kindly tell me of a good cement which will resist sulphuric acid and hold glass and lead together.—H. R. Yardley.

Crimson Spirit.—This term appears to mean a solution of chloride of tin, and it is likely that, under the name alluded to, the solution you require is sold by drysalters, but the name is possibly also given to an ammoniacal solution of cochineal.

Electro-Deposition.—(Reply to "Inquirer.")—You may use a solution of platinum chloride in ether, or you may rub the objects you desire to be platinised with a moistened mixture of platino-chloride of ammonium and cream of tartar. For electro-depositing it appears that the double chloride of platinum and potassium, dissolved in a solution of caustic potassa, is the best fluid; take care to have the iron and copper perfectly bright, well polished, and free also from grease. Aluminium does not appear to have been deposited in the way you mention.

Assaying Iron Pyrites.—Is the ordinary method or methods of assaying iron pyrites for gold defective and faulty? My reason for asking is that it is beginning to be believed that pyrites, such as are worked for sulphuric acid, contain much more gold than is ordinarily admitted, that there is a decided loss in roasting (Crookes and Röhrig's "Metallurgy," Gold and Silver, pp. 629—630, and authorities there cited), and that a method has been devised with which the presence of gold in large amount can be demonstrated. Assays of mine, made upon 8 and 16 oz. lots, showed from 1½ to 40 ozs. gold per ton of 2000 lbs, in pyrites where most other assayers found no gold, and some, in California, ½ oz. The trouble is that no two assays made from pyrites shovelled from the self-same barrel could be made to agree.—J. M. M.

TO CORRESPONDENTS.

*** Vol. XXIII. of The Chemical News, containing a copious index is now ready, price 11s. 4d., by post, 12s., handsomely bound in cloth, gold-lettered. The cases for binding may be obtained at our office, price 1s. 6d. Subscribers may have their copies bound for 2s. 6d. if sent to our office, or, if accompanied by a cloth case, for 1s. Subscribers wishing to complete their sets of volumm are requested to apply to the publisher, who will give these information respecting scarce numbers and volumes. Vol. xxiv. commenced on July 7th, and will be complete in twenty-six numbers. Reading Cases, price 1s. 6d. each, post free, may also be obtained at the Office.

W. F. Catcheside.—There is a letter for this correspondent at our Office.

A. K. & Co.—Fuller's earth is found in Surrey, Kent, Nottinghamshire, and in Scotland. Address to Mr. James Cawley, Nutfield, Surrey.

Carbasotic.—(1). Picric acid has been tried as a tonic and anti-scorbutic in doses varying from 1-12 to ½ grain, but it is not found to possess any marked medicinal virtues, and its use imparts a yellow tinge to the skin and to the white of the eye. (2). Nitrites when properly prepared are neutral salts; there ought therefore to be no decomposition with the salt you mention. Watts's "Dictionary of Chemistry" will give you further information on the subject.

Dr. E.—There is a paper on the subject in the "Handwörterbuch der reinen und Angewandten Chemie," vol. v., p. 301; consult also Payen, "Précis de Chimie Industrielle," 5th edition, vol. i., p. 432. Both these works are at the Patent Office Library.

J. Young.—The full translation will appear as soon as possible.

C. R. C. Tichborne.—Received with thanks.

J. Galletly.—A proof shall be forwarded.

J. Fyfe.—Bisulphite of ammonia is a solid; you can obtain it from any good operative chemist in London.

NOTICE TO AMERICAN SUBSCRIBERS.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 621.

ON ISODINAPHTHYL.

By WATSON SMITH, F.C.S.

INSTEAD of at once dealing with the main subject of this paper, I think a brief view of certain of the results of researches of several eminent chemists, directly bearing on the matter in hand, would be at once interesting and desirable.

The peculiar hydrocarbon diphenyl was first obtained by Fittig* by treating monobrombenzol with sodium :—

$$2C_6H_5Br + 2Na = 2NaBr + \left.\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\right\}.$$

Now Berthelot†, in the year 1866, by passing benzol vapour through a porcelain tube heated to bright redness, obtained diphenyl as the chief product of decomposition. Berthelot distinctly says, "the body so obtained is a beautifully crystalline substance, which is identical with Fittig's diphenyl, possessing exactly the melting- and boiling-points given by Fittig, and agreeing generally with that body." A small quantity of chrysene is also said to be formed, and of a solid resinous body, of an orange colour, which is but slightly soluble in alcohol, rendering the same fluorescent. The formula

$$2C_6H_6 = \underset{\text{Diphenyl.}}{\left.\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\right\}} + H_2$$

represents this decomposition.

(1). About the commencement of the year 1867‡, Dr. F. Losson found that dinaphthyl could be obtained from monobromnaphthalin by the action of sodium, just as Fittig had obtained diphenyl from monobrombenzol—

$$2C_{10}H_7Br + 2Na = 2NaBr + \left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\}.$$

At the same time he (Lossen) found there was also a small quantity of a polymer formed, which he obtained as a chocolate-brown powder, scarcely at all soluble in alcohol, but more so in ether. It was easily soluble in carbonic disulphide.

(2). Dr. Lossen also found that he could obtain dinaphthyl by the oxidising action, upon naphthalin, of a mixture of manganese peroxide and sulphuric acid—

$$\left.\begin{matrix}2C_{10}H_7\\H\end{matrix}\right\} + O = \left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\} + H_2O.$$

This mixture he found acted energetically upon naphthalin, there being liberated, with strong effervescence, much carbonic dioxide. When the action was completed, the contents of the retort in which the process was carried on were diluted with water, manganese sulphate and phthalic acid were dissolved out, and unaltered manganese peroxide and a resinous body left behind. The undissolved portion was boiled with absolute alcohol; and the impure body crystallised out from the filtered solution was repeatedly re-crystallised from alcohol. The dinaphthyl was thus obtained in pearly shining scales of a very light yellow colour. Lossen found that it was only possible to obtain the body quite colourless by sublimation.

Thus obtained, dinaphthyl was found to be much more easily soluble in ether than in alcohol, crystallising therefrom in moss-like clusters. By slowly cooling a solution of this body in a mixture of ether and alcohol, it was obtained crystallised in well-formed regular octahedra. It is very soluble in carbonic disulphide. Benzol dissolves it to much the same extent as alcohol does; and it crystallises from the solution of that body in the same form as it does from alcohol. Dinaphthyl melts at 154° C. Its boiling-point lies above that of mercury. Robert Otto* and Gustav Möries repeated Lossen's experiments with precisely the same results; but they tried, in order to get dinaphthyl formed more easily, and in larger quantity, to form it by first obtaining the mercury compound mercuriodinaphthyl—

$$\left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\} Hg''$$

by heating monobromnaphthalin with sodium amalgam (Na_2Hg''), and raising this to a red heat with soda-lime in a porcelain tube. Mercury and a yellow crystalline mass were obtained, the greatest portion of the latter consisting of naphthalin. This yellow mass, on boiling with alcohol, yielded on cooling the rhombic tables of naphthalin abundantly, the mother-liquors exhibiting strong green fluorescence by reflected light and furnishing on evaporation a yellow mass, which, after suitable purification, deposited from alcohol small canary-yellow shining leaf-life crystals, which melted at 133° C. This body was readily soluble in alcohol, ether, and benzol. The solution of the pure hydrocarbon was no longer fluorescent.

They made a combustion, which did not seem to be satisfactory, as they only had 0·066 grm. of substance to work with, and of this they did not feel sure of the perfect purity. The percentage composition they obtained almost exactly corresponded with that of naphthalin. They consider the action to be chiefly

$$\left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\} Hg'' + H_2O = 2C_{10}H_8 + HgO.$$

About the close of the year 1866, Berthelot† concluded his remarkable series of experiments on the action of certain hydrocarbons upon one another when conducted through a red-hot tube. In one of these experiments he passes the vapour of naphthalin with hydrogen through the tube; and as to the result he says, "Almost no action at all takes place, the naphthalin remaining almost quite unaltered, and only a little benzol and acetylene are obtained."

$$\underset{\text{Naphthalin.}}{C_6(H_4[C_2H_2(C_2H_2)]} + H_2 = \underset{\text{Benzol.}}{C_6H_6} + \underset{\text{Acetylene.}}{2C_2H_2}.$$

About nine months ago I undertook, at the suggestion of Mr John Barrow, in the laboratory of whose works I was then engaged, the investigation of the action of heat upon naphthalin, with the object of discovering whether by this means it is possible to obtain anthracene, according to the equation $7(C_{10}H_8) = 5C_{14}H_{10} + 6H$.

This reaction Mr. Barrow supposed might take place on passing the naphthalin vapours through a red-hot tube. I accordingly tried a number of preliminary experiments in this direction, of which the results were as follows:—

(1). The odour and colour of the naphthalin which came through the tube were perceptibly altered; the colour became a deeper brown in proportion as the temperature of the tube was higher. At an incipient white heat a considerable quantity of black smoke came over with the distillate.

(2). A gaseous product was obtained proportionately larger in amount as the temperature employed was higher.

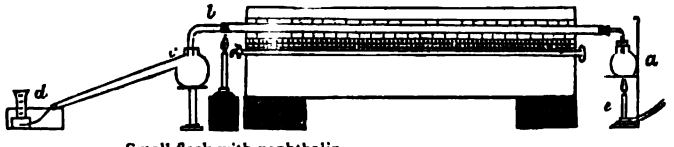
(3). On distilling the brown mass of naphthalin coming through the tube, there was invariably left in the retort a minute quantity whose boiling-point was above 350° C.

I now prepared some pure naphthalin, by treating a quantity of the crude stuff, whilst fused, with warm con-

* Read before the Manchester Literary and Philosophical Society.
† *Ann d. Ch. und Pharm.*, vol. cxxi., p. 361, and vol. cxxxii., p. 201.
‡ *Zeitsch. f. Chemie*, 1866, Dec. 14, p. 707.
‖ *Ann. d. Ch. und Pharm.*, Band cxliv., p. 71.

* *Ann. d. Ch. und Pharm.*, 1868, vol. cxlviii., p. 164.
† *Zeitschrift f. Ch.*, 1867, Jan. 31; and *Compt. Rend.*, vol. lxiii, p. 998 and 1077.

centrated sulphuric acid (about 5 per cent by volume); and, after separating, it was again shaken with hot caustic soda solution of sp. gr. = 1·18. The naphthalin thus treated was now purified by fractional distillation, the portion boiling between 210° C. and 212° C. being kept. After another distillation, the perfectly white product obtained was taken for experiment. Into a small flask (*a*) 152·6 grms. of the pure naphthalin were introduced, and the flask was connected with an iron tube (½ inch diameter), filled with small fragments of charcoal, to afford a large heated surface. That charcoal had no chemical influence beyond that of affording a large heated surface, was proved by the fact that the same results were obtained when fragments of pumice stone, soda-lime, brick, or the empty tube itself was employed. With the other end of the iron tube was connected a bent glass tube (*b*) (½ inch diameter), fitting air-tight into a retort (*c*) so deep that the end thereof should be below the aperture of the retort-stem. With the extremity of the retort-stem was connected another bent glass tube, dipping into the pneumatic trough, over which was a jar of 340 c.c. capacity, to collect the gaseous products evolved. The iron tube was placed in a "Griffin's gas-furnace," where it was raised to a



a. Small flask with naphthalin.
b. ½-inch iron tube, filled with small fragments of charcoal.
c. Retort, to collect distillate.
d. Gas-jar, to collect and measure gas evolved.

bright red heat, in some parts approaching to whiteness. When the iron tube was red-hot, the naphthalin was distilled through cautiously. As soon as it made its appearance in the tube (*b*), the latter was heated up somewhat strongly, so as not to allow the solidification of the naphthalin. The distillate, when it commenced to run down the bend to the cool part of the tube in the retort, was worked over for a minute or two as briskly as possible; or it would certainly have stopped up that cool part of the tube which dipped below the stopper of the retort, causing a dangerous explosion from the little flask (*a*).

When the naphthalin began to run fluid into the retort, the distillation was kept up briskly for a time, all solidified particles being speedily re-melted by the hot stream, and carried before it into the retort. All danger of stopping up then ceased, as the whole apparatus was too hot to permit solidification in any part thereof.

The substance distilling over was of a deep brown-red colour, and had acquired a peculiar odour, in addition to that usual in naphthalin. The gaseous product obtained was just sufficient in the first trial to fill the gas-jar (340 c.c.). The distillation was carried on till the flask was just dry, when, on removing the flame of the lamp, there was always a back rush of vapour, accompanied by the dropping back of a dark-looking fluid, amounting in this (the first) distillation to about 1 c.c.

This small quantity of dark-looking substance which had dropped back out of the hot tube, was poured out into a small capsule, and carefully preserved, as the first contribution towards a quantity of the crude substance.

What distilled over into the retort (*c*), of reddish-brown colour, was now fused, and poured back again into the little distillation-flask (*a*), from which it was again distilled through the red-hot tube as before, in the first experiment. It not only yielded a little freshly formed substance of high boiling-point, but also left behind a little which had been formed, and carried over amongst the bulk of the naphthalin, in the first distillation. Thus a somewhat larger yield was obtained in the second and subsequent distillations than in the first. These distillations were repeated seven times, to accumulate crude material.

The temperatures at which the tube was maintained were not uniform in each experiment; and the volumes of gas evolved was found to vary accordingly. Thus, in the second distillation, the heat was only just perceptibly red, and very little gas was obtained (about 5 c.c. or so).

Quantities of Gas Liberated during each Experiment, the Heat Employed Varying in Intensity.

Distillation.	Intensity of heat of tube.	C.c. of gas evolved.
1st.	Bright red heat.	300
2nd.	Only just red.	Very little, about 5 c.c.
3rd.	Bright red.	460
4th.	Do.	300
5th.	Do.	500
6th.	Do.	403
7th.	Do.	300
8th.	Do.	225
	Total	2493

Average temperature = 15° C.

The above measurements of gas evolved were not made with any great accuracy, but are just fair approximations. This gas was tested, and yielded the following results:—

(1). It gave no milkiness with lime-water.

(2). It burnt, on ignition, with a lambent bluish flame, tinged at times with a glimmering of the white carbon flame, and, on shaking with lime-water, gave therewith a very slight milkiness; but almost always there was not the slightest glimmer of the carbon flame, and not the slightest cloud with lime-water after burning.

(3). The gas, mixed with half its volume of oxygen and inflamed, exploded loudly.

From these evidences we gather that the gas is hydrogen; and the glimmering at times of the carbon flame was probably due to the presence of a little naphthalin vapour mechanically carried over, though certainly a trace of acetylene might be present at times, and would then account for it.

If a calculation be made from the volume of gas evolved, it will be found that this quantity is too great to stand good for the equation

$$7C_{10}H_8 = 5C_{14}H_{10} + 6H.$$

Weight of H actually evolved . . . . = 0·2107 grm.
" " required for the above reaction = 0·1861 "

The above is sufficient to show that, as the amount of hydrogen evolved was too great to stand good for the above equation, the body formed from the decomposition (seeing that there was no appreciable separation of carbon) must be richer in carbon and poorer in hydrogen than anthracene is. This point will be again referred to.

Now the crude substance which had been accumulated amounted to 26·3 grms,—that is, 17·23 per cent on the naphthalin used. These 26·3 grms. of crude substance were placed in a small retort with thermometer, and submitted to fractional distillation. A very small quantity of naphthalin came over first, below 220° C.; and then the temperature very rapidly rose to considerably above 360° C., when most of the body distilled over, leaving a minute quantity of pitch in the retort. In distilling, almost all the substance solidified in the neck of the retort, which had to be kept very hot towards the end of the operation, to get the substance to run down fused into the receiver. At this stage the distilled product closely resembled anthracene in a similar stage of purification, but did not possess the peculiar odour which characterises that body in the crude state, being almost entirely free from odour.

To purify further, the solid hard substance was crushed in a mortar and made into a thin homogeneous paste with light shale spirit (or petroleum spirit), in both of which it

is much less soluble than in benzol. It was then drained on a filter, washed again several times with petroleum or shale spirit, drained, pressed in blotting paper, and dried at a temperature fully sufficient to volatilise the spirit. By this washing it was freed from a small quantity of resinous matter, and from a citron-yellow coloured substance, which coloured the spirit mother-liquors yellow by direct transmitted light, exhibiting a fine blue fluorescence by reflected light.

This fluorescence is similarly acquired when any fluids possessing any solvent action are substituted for the shale spirit.

Finally, the dried substance was sublimed at as low a temperature as possible. The sublimate consisted of a faintly yellowish-white inodorous powder, precisely resembling commercial anthracene sublimed under like conditions, but not possessing the slightest odour. The sublimate may also be obtained in delicate little plates, by very careful and slow sublimation. When possessing the faintest yellow tint, this powder imparts a delicate blue fluorescence to any solvent used.

In another preparation of a further quantity of crude substance, a large iron tube, about 4 or 5 feet long, and about 3½ inches diameter, was used, being placed in a charcoal fire. The heat was almost to whiteness. In this case there was a connection with a pneumatic trough, the open end of the tube dipping into an iron pan acting as receiver. Immense volumes of black smoke were liberated at first;* however, on moderating the heat somewhat, whilst the dense black smoke still poured out, a quantity of undecomposed naphthalin and other matters came over, dropping into the receiver. The black, almost solid mass in the receiver, after being put back into the one-gallon iron still employed, and re-distilled several times, at length left a residue, which, on fractional distillation, proved to contain some undecomposed naphthalin, this passing over below 220° C. A very appreciable residue however remained, which was distilled over, the temperature rising above 350° C. In this case, however, the solid hard substance obtained had a deep yellow tint, almost inclining to orange; and on triturating in the mortar with benzol (cold), the latter dissolved out a sticky resinous body, which coloured it a fine deep red. After washing once or twice, the crude body remaining was quite freed from this sticky substance, and remained a sulphur-yellow powder. This yellow colour was very much more intense than in the case of the experiments on the minor scale. By re-crystallisation from benzol and sublimation, it was obtained colourless.

A small quantity of this crude orange-yellow body, treated with cold concentrated sulphuric acid, yielded a very fine purple solution, better developed on warming. On heating more strongly, the colour changed to an indigo tint, and then to a dull green. As this reaction is mentioned by C. Liebermann as characteristic of chrysene, I venture to suggest that probably chrysene was present in this yellow crude substance.

With a benzol solution of picric acid in excess, no red compound was formed with this body. It was found to be much more insoluble in alcohol and shale spirit than anthracene is; from these solutions it separates on cooling in larger or smaller rhomboidal plates, according to whether the solutions are more slowly or rapidly cooled. It is almost insoluble in ether, but easily soluble in oil of turpentine, from which it crystallises in beautiful lance-shaped crystals, congregating in clusters. It is, like anthracene, very soluble in carbonic disulphide, even in the cold. The thoroughly purified substance imparts no longer any fluorescence to solvents.

Lossen's Dinaphthyl. Solubility, &c.	Isodinaphthyl. Solvents.	States of Solubility.	Crystalline form.
The reverse; more soluble in ether than in alcohol.	Proof spirit.	Scarcely at all, even on boiling with excess.	On cooling, a few small plates separate out.
	Ether.	Only very slightly.	
	Absolute alcohol.	Soluble on boiling.	Beautiful rhomboidal plates, which, on drying carefully, overlap and laminate, and have a beautiful silky appearance. They possess a very faint delicate greenish colour.
From alcohol separates in moss-like clusters.	Methylated spirit.	More so.	
In octahedra from ether-alcohol mixture.	Wood spirit.		
	Light petroleum spirit, sp. gr. 0·710.	Still more soluble than in the above.	Rhomboidal plates.
	Light shale spirit, sp. gr. =0·737.	Rather more than in petroleum spirit.	
	Carbon tetrachloride.	Slightly less soluble than in benzol.	Ditto.
About the same as in alcohol.	Benzol.	Sparingly in the cold, pretty freely in the hot fluid.	
Easily soluble.	Carbonic disulphide	Easily soluble, even in the cold.	
	Oil of turpentine.	Very easily soluble.	Delicate white lance-shaped crystals, in clusters.
Melting-point = 154° C.	Melting-point = 204° C.		
Boiling-point = above 350° C.	Boiling-point = much above 360° C.		

The fusing-point is from 200° to 204° C., and the boiling-point considerably over 360° C., certainly higher than that of anthracene. The subliming-point of this body lies considerably below its boiling-point, like that of anthracene.

A portion of the pure substance was treated with two parts of potassium bichromate and sulphuric acid, when oxidation took place as energetically as in the case of anthracene under like treatment. No crystals bearing any resemblance to those of anthrachinon could be obtained on treating with benzol. From the product which was obtained, no substance similar to alizarine, nor in fact any colouring matter, could be obtained.

Cold sulphuric acid is without action upon this body; but, when heated, the acid slowly dissolves it, when, if it be quite pure, a very faint purplish-tinted solution is

* Probably caused by the admittance of a small amount of air accidentally.

formed; if not quite pure, but containing a trace of the yellow-coloured body mentioned before, a violet or purple solution is formed, becoming green and then reddish-brown on further warming.

Hot nitric acid oxidises it, with liberation of nitrous fumes, forming heavy oily drops of a nitro-compound of a red colour; on further boiling with a large excess of acid, this compound is slowly dissolved. On addition of water, a light yellow floccular precipitate is thrown down abundantly.

Placed in a glass tube, and chlorine passed over it in the cold, no action takes place; and even on warming to a considerable extent, no change appears to occur. Treated with bromine in the cold, combination takes place with very energetic action.

After many repeated experiments on the subject, I have come to the conclusion that it is impossible to distil pure naphthaline to dryness in any quantity without this body being formed in minute quantity. This may be observed by dipping the thermometer down nearly to the bottom of the retort when the last minute quantity is being vaporised; the thermometer, lowered into this vapour, will be observed speedily to indicate a high temperature, the mercury rapidly rising towards 350° C. If this does not take place on the first distillation,—if the naphthaline, all of which has passed over, be again introduced into the retort, and the same plan again proceeded with, this observation may be made successfully, as a small quantity of high boiling substance carried over in the first distillation will be increased by a further accumulation in the second, and an appreciable quantity will be left behind.

A quantity of the pure substance crystallised from absolute alcohol was taken for analysis. The following results were obtained:—

I. 0·1240 grm. of substance gave 0·4307 grm. CO_2 and 0·0624 „ H_2O

II. 0·1237 „ „ „ 0·4284 „ CO_2 and 0·0626 „ H_2O

	I.	II.	Calculated for $C_{10}H_7$ $C_{10}H_7$
Carbon.. ..	94·72	94·46	94·49
Hydrogen ..	5·59	5·62	5·51
	100·31	100·08	100·00

A calculation may also be made from the weight of hydrogen given off in the reaction in the hot tube; and I think it is well worthy of notice, as it was this observation which first led me to think the reaction must be as follows, viz.:—

$$2C_{10}H_8 = \left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\} + 2H.$$

Weight of naphthaline converted = 26·3 grms. (about).
Volume of hydrogen at 0° C. evolved = 2363 c.c.

Grm. Hydrogen.

Then $\frac{2363}{11200}$ = 0·2109 actually obtained.

256 2

$2C_{10}H_8$ lose H_2 .·. 26·3 lose 0·2055 calculated.

Difference .. .. .. 0·0054

For the formula

$7C_{10}H_8 = 5C_{14}H_{10} + 6H$, 0·1861 should be liberated.

Conclusions.

I find from the foregoing facts:—

(1.) That, whereas Berthelot found that diphenyl could be obtained by the action of a high temperature upon benzol, identical with that obtained by Fittig from brom-benzol, the analogy does not appear to hold good with dinaphthyl formed from naphthaline.

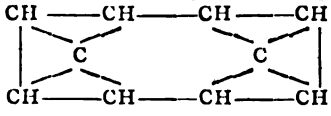
(2.) That a substance having a higher melting-point, and differing in many respects from Lossen's dinaphthyl, is formed.

(3.) That this body is the chief product of the action of heat upon naphthaline, whether a low temperature, just sufficient to induce decomposition, or a temperature close upon a white heat be employed.

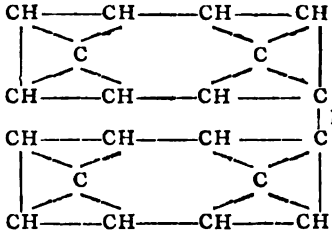
(Finally.) Observing the percentage composition of this body, and the volume of hydrogen approximatively found to be evolved in the decomposition, also that the boiling-points of dinaphthyl and this body are by no means very widely different, possibly not far apart, I propose to regard it as an isomer of dinaphthyl, and to name it accordingly isodinaphthyl—

$$\left.\begin{matrix}C_{10}H_7\\C_{10}H_7\end{matrix}\right\}.$$

If naphthaline be graphically represented as—

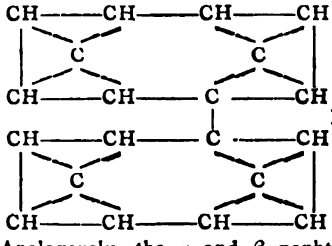


Dr. Lossen's dinaphthyl would appear to be—



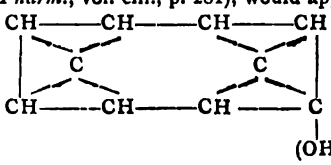
α Dinaphthyl.
Melting-point = 154° C.

whilst the isodinaphthyl obtained by myself would stand—

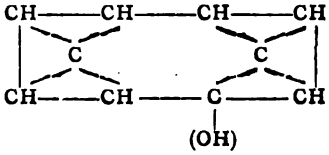


β Dinaphthyl.
Melting-point = 204° C.

Analogously, the *α* and *β* naphthols investigated by Wichelhaus, and also by Schaeffer (*Ann. der Chemie und Pharm.*, vol. clii., p. 281), would appear thus:—



α Naphthol.
Melting-point = 94° C.
Boiling-point = 279° C.



Naphthol.
Melting-point = 122° C.
Boiling-point = 287° C.

Action of Chlorine.—The effect of passing chlorine, together with naphthaline vapour, through a red-hot tube was also tried in such a way that the vapours should only come into contact in the hot tube. It was then found that complete decomposition took place, with large separation of carbon in dense black smoke.

I cannot conclude without heartily thanking Mr. Barrow, in the laboratory of whose works these experiments were carried out, for his kind assistance. My sincere thanks are also due to Professor Roscoe and Mr. Schorlemmer for their kindness in placing the combustion-apparatus in Owen's College laboratory at my disposal, and for their kind attention to me whilst there engaged.

ON A PARAFFIN HAVING A HIGH MELTING-POINT.

By JOHN GALLETLY.

IN manufacturing paraffin oil from Boghead coal, I happened to have at one time as the final portion of the crude oil condenser, an old boiler to which the entrance and exit pipes were attached close to the top, so that it could become nearly filled with naphtha without the passage of the gas through it being stopped. This portion of the condenser never became warm in the slightest degree, but besides filling rapidly with naphtha, a considerable quantity of a dark tarry matter accumulated in it which had a brittle crystalline feeling when pressed between the fingers. This, I supposed at first, was due to the presence of a crystalline substance, but subsequently found it was owing to the manner in which the tarry matter encrusts itself as it condenses or deposits. When this solid matter is boiled with naphtha, a thick fused cake is found to settle down, and a dark brown powder remains floating through the liquid. On filtering, a very dark coloured fluid is obtained, which solidifies on cooling, and the brown powder remains on the filter. The fused cake and this dark powder are insoluble in any ordinary liquid in which bituminous matters dissolve, not volatile without decomposition, and therefore furnishing no easy means of purification or recognition as definite substances.

On pressing the naphtha solution after cooling and solidification, the crude hydrocarbon which forms the subject of this notice, is obtained as a soft dark coloured cake. Its purification is effected by repeated crystallisations from naphtha, which are easy enough for the first three or four times, but then become very troublesome on account of the paraffin passing through the cloth along with the naphtha. Bees'-wax behaves in a similar manner when an attempt is made to crystallise it, and it would be almost as easy to press starch-paste into a firm cake. However, I used very gentle pressure in woollen cloths, allowing the mother-liquor to soak into dry bricks. This was repeated eight or ten times, using with the last naphtha a little animal charcoal. The product, after being filtered, had steam blown through it to expel the naphtha, when hard cakes were obtained of a yellowish colour. This yellow colour was no doubt due to a very small quantity of some impurity very difficult to remove.

As thus obtained this substance resembles bees'-wax very closely, but is a little more translucent and does not exhibit any conchoidal fracture when broken. It has a much harder ring than ordinary paraffins when two pieces of it are struck together. Its melting-point is very high, being 80° C. This it attains after the first few crystallisations, and remains unaltered however often this process be repeated with considerable quantities of fresh naphtha. It is evidently, then, an individual substance, not a mixture of several homologues like ordinary paraffins. It seems to be separated from the paraffins accompanying it in the crude oil by a considerable gap. The highest of these after more than a dozen crystallisations, the later of which making little alteration, had a melting-point of 65·5° C.; the quantity obtained being reduced to a fifteenth of the weight of the material commenced with, which was paraffin melting at 56° C.

The elementary composition of this paraffin is sensibly that of the other paraffins and of olefiant gas. Below are the numbers I obtained alongside the analyses of some other paraffins, and the composition of olefiant gas.

	Paraffin 80° C.	Olefiant gas.	Anderson from Boghead 52°.	Brodie from Chinese wax 58°.	Brodie from Bees'-wax 62°.
Carbon ..	85·2	85·7	85·15	84·90	85·31
Hydrogen ..	14·4	14·3	15·40	14·21	14·44

By placing the composition of olefiant gas alongside these analyses, I do not mean to differ with those chemists who regard the paraffins as homologues of marsh-gas. On the contrary, I think the very existence of this new body, which must have a very complex molecule, as so much evidence in favour of this view, the marsh gas series being so much more stable than the olefines. The numbers, however, are useful as showing among other things that the elementary composition as determined by experiment cannot settle the question.

Besides the boiling-point being very high, namely, not far short of a red heat, this paraffin partially suffers a change on distillation, apparently about one-half of it being converted into liquid hydrocarbons. This renders a determination of its vapour density unusually difficult, and I have not attempted it.

I may state that the solid portion, after distillation, on being washed and crystallised from naphtha, retains its melting-point unaltered.

It seems to be a rule that the paraffins obtained from any particular source have solubilities diminishing as their melting-points get higher. The body under notice is not an exception to this rule, and the following table gives the solubility of several paraffins in well rectified commercial benzole :—

Melting-point of Paraffin.	Solubility in 100 c.c. at 18° C.
35·0° C.	133·0 grms.
49·6° C.	6·0 ,,
52·8° C.	4·7 ,,
65·5° C.	1·4 ,,
80·0° C.	0·1 ,,

Although only one part of the paraffin melting at 80° C. dissolves in 1000 of benzole at 18° C., it mixes with it in all proportions above its melting-point.

The densities of the paraffins also show an increase with a rise in their melting-points, but I may state that it is a little difficult to obtain exactly the same numbers with two different samples having the same melting-point. One cause of this may be owing to more or less rapid cooling, but the subject requires investigation.

The following are numbers I obtained with paraffins all from Boghead coal :—

Melting-point of Paraffin.	Specific gravity.
32·0° C.	823·6
39·0° C.	848·0
40·5° C.	852·0
53·3° C.	911·0
53·3° C.	909·0
58·0° C.	924·3
59·0° C.	924·8
80·0° C.	940·0

Brodie viewing them when he published his papers as olefines, gives the formula of cerotene as $C_{27}H_{54}$ and its melting-point at 57° to 58° C., and melene as $C_{30}H_{60}$ with a melting-point of 62° C. It is probable enough from the properties of the hydrocarbon under consideration that its molecule contains nearly half as many more atoms as melene.

Picric acid forms no compound with this paraffin.

When melted over sulphuric acid, this body gives a greasy black mass resembling drawing-chalk. A mark made on paper with this substance is scarcely to be distinguished from that of a black-lead pencil. Sulphuric acid attacks all the paraffins more or less when highly heated with them, but more easily the higher their melting-points. The carbon which separates by acting on paraffin of 80° C. melting-point is in a state of very fine division, and when the dark cake so procured is boiled with naptha the carbon passes along with the liquid through the pores of fine filter-paper.

Brodie has examined the action of chlorine on melted cerotene. He gets first a change to a waxy looking substance, then it turns gummy, and ultimately a transparent resin, becoming harder as more chlorine is absorbed; several weeks being required to complete the changes,

and the body $C_{27}H_{32}Cl_{22}$ being formed. With ordinary paraffin, Mr. James Young, jun., obtained a similar result up, at least, to the gummy stage, and afterwards Mr. W. MacIvor in Mr. Young's laboratory carried on the action till a brittle resin was obtained. On the high melting paraffin under notice chlorine acts much more rapidly, darkening it almost immediately, and giving, after a time, a thick black oily or gummy body, turning quite thin when gently warmed. I did not persevere further with the chlorine treatment after reaching the viscid liquid stage, but now subjected the material to distillation. Torrents of hydrochloric acid were evolved, and a small quantity of an oil of a strong, very peculiar odour. I can give no exact idea of this odour, and do not know to what substance it belongs, but I at once identified it as that of the oil Mr. Young obtained by distilling his viscid chlorinated paraffin. The residue of charcoal left after distillation was large.

Heated with nitric acid (sp. gr. 1·4) the 80° C. paraffin is converted in an hour or two chiefly into nitro-compounds, which are readily soluble in caustic alkalies. Ordinary paraffins undergo, as has been pointed out,* the same change with more protracted boiling. With the latter, besides butyric acid, there are acids of the succinic series produced, of greatly varying melting-points, but how many of them, from the difficulty in their separation and our imperfect knowledge of their distinguishing properties, it would not be easy to determine. The chief product is a thick clear oily nitro-compound, miscible with the warm nitric acid, and soluble in alkalies, giving when distilled large quantities of ammonia and the interesting pyridine bases. There does not appear to be a trace of aniline produced; very slight traces of aniline along with these bases giving with chloride of lime solution a bright characteristic green colour, obtained generally with the bases from shales poor in nitrogen.

A candle made of this high melting paraffin burns with a small but very clear smokeless flame, lasting a very long time. It would, however, be too expensive a material to manufacture for making candles. It occurs in the shale products as well as in those from the cannels, and could be obtained in some quantity if a tempting price were offered for it.

I hope to be able soon to complete another paper on paraffin. It is very striking how limited our knowledge is of this subject compared with our information regarding the benzole series and naphthalin. The derivation of its name has, it may be presumed, chiefly to answer for this condition of affairs.

ON THE

CHANGE OF COLOUR PRODUCED IN CERTAIN CHEMICAL COMPOUNDS BY HEAT.†

By Professor EDWIN J. HOUSTON,
Of the Central High-School of Philadelphia.

(Concluded from p. 180).

Solids.—The reduction of temperature was obtained by the evaporation of ether, bisulphide of carbon, or liquid sulphurous acid. The liquid was placed in a metallic box, furnished with eight vertical sides. Strips of paper, on which the substances were painted, were pasted on the sides of the vessel. Corresponding strips of paper, similarly prepared, were kept for comparison. Cold was produced by blowing a blast of air from a small bellows upon the surface of the liquid. The results obtained were somewhat vitiated by the deposition of the moisture of the air on the sides of the metallic vessel. This difficulty was obviated to some extent by having the paper slip, kept for comparison, equally moist.

The results, which are open to this objection, were as follows:—

Sulphide of Mercury.—Changes from a bright red to a brighter red.

Bisulphide of Tin.—Changes from a brownish orange-yellow to a lighter brownish-yellow.

Subsulphate of Mercury.—Changes from a yellow to a greenish-yellow.

Iodide of Lead.—Changes from an orange to a lighter orange.

Chromate of Lead.—Changes from a yellowish-orange to a yellowish-green.

The substances occupying the remaining sides of the vessel did not present any appreciable change.

Liquids.—The experiments with liquids were, with a few exceptions, of an unsatisfactory character. The solvent in most cases was water, and the cold could not safely be pushed lower than the point of maximum density of the solutions. The solutions were prepared in test-tubes, in a manner similar to the experiments with heat. The limitation in the application of cold was, in all probability, the cause of the changes not being of a more decided character.

The following are among some of the substances experimented with:—

Sulphate of Copper.—Solution of a pure blue; deepens on the application of cold.

Ferrocyanide of Potassium.—Saturated solution of a nearly pure yellow; becomes tinted slightly with green.

Chloride of Copper.—Solution of a bluish-green; becomes a more decided bluish-green.

Sesquichloride of Iron. — Solution, orange-yellow; becomes an orange-yellow in which the yellow is more predominant than in the preceding.

Sesquinitrate of Iron.—Solution, orange-yellow, like the chloride.

Wishing to obtain a solution that could be exposed to a much lower temperature without freezing, a solution of the chloride of copper in ether was prepared. The colour was yellowish-green. When exposed to a low temperature by the evaporation of the bisulphide of carbon, the colour changed very decidedly to a pure green. It is purposed, at our earliest convenience, to pursue these investigations at lower temperatures obtained by means of solid carbonic acid and ether. Meanwhile, we would be much pleased if any investigators throughout the country, who may be using a solution of the solid carbonic acid in ether, would observe the action of intense cold on the etherial solution of chloride of copper, or on any solution of a similar nature.

The law already stated seems now to have been clearly established, both by the number of cases that come under it, and by the fact that, so far, no exceptions have been noticed. It can hardly be urged, with fairness, that all coloured compounds should be equally influenced by the action of the less rapid heat vibrations, for the differences presented by bodies, as regards their transparency or opacity to light, or their diathermancy or adiathermancy to heat, clearly indicate a very great difference in their molecular structure, which difference offers reasons amply sufficient to explain why the colours of some compounds should be more influenced by heat than others. Again, there can be little doubt that more extended observations will increase the great number of compounds already noticed. For instance, the well-known change from red to yellow presented by the red iodide of mercury, dissuaded us at first from submitting it to an experiment. On a careful trial, however, it was found to illustrate the law, changing to a decidedly darker red up to the temperature requisite to alter its crystalline form.

The theory also receives further support and confirmation from the following considerations.

It is well known that when a yellow and a red substance, which have no chemical action on each other, are mixed together, the resulting colour is orange. The explanation is undoubtedly to be found in the raising of the

* I regret not having an opportunity of referring to a memoir which was published on this subject.

† From advance-sheets of the *Journal of the Franklin Institute*. Communicated by Dr. W. H. Wahl.

less rapid red vibrations by the yellow, and the consequent lowering of the yellow by the red, the mean resulting vibration being that capable of producing orange light.

This case, though analagous to the change produced in colour by the action of the heat, is not strictly identical with it. In an orange substance, which emits red light when heated, the change is produced as follows:—

Its molecules, while vibrating in periods requisite to produce orange light, are, at the same time, forced to accept the less rapid vibrations of heat. They are unable to do this without lowering the rapidity of the light vibrations, and the emitted light is red. Here, however, the molecules themselves transmit red light to the ether surrounding the intermolecular spaces, which ether in its turn transmits it to the eye for the purposes of vision. Now, in the case of the orange light emitted after the commingling of a yellow and a red substance, as no change other than that of mixture is produced, we must still conceive of the particles of the red and of the yellow substance vibrating in periods requisite to produce red and yellow, and the interference taking place in the intermolecular spaces. Briefly the difference is as follows:—

In the substance whose colour is changed by heat, the *molecules* transmit the changed light directly to the surrounding ether, while in the commingled bodies, the change occurs in the ether surrounding the molecules. The two cases become strictly analogous when we mingle red and yellow light.

In accordance with this view, pure orange and green when mingled should produce yellow; yellow and blue, green; green and indigo, blue; and blue and violet, indigo.

When we come to the boundary of the spectrum on the light side, in other words when we come to the violet, an apparent objection meets us. We know that violet can be produced by the mingling of indigo or blue light with red. That is two lower vibrations, and one of them at the lowest extremity of the visible spectrum, produce by their mingling a resultant higher vibration, a fact certainly improbable, and seemingly at variance with theory. It must, however, not be forgotten that the violet of the spectrum marks not the limit of the etherial vibrations, but merely our power of appreciating them. The existence of higher vibrations is shown by the actinism of the spectrum, or the effect in producing chemical decomposition, existing some considerable distance beyond the violet. In fact, Herschel, by concentrating this invisible light beyond the violet, succeeded in rendering it visible, and gave its colour the name of lavender. This light is of a pale red, inclining to a tinge of violet.

The explanation is now simple. The violet of the spectrum is not produced by the mingling of the indigo or blue with the remoter or lower red, but with that of the higher red or lavender. Indeed, we are strongly led to the belief in the existence of a spectrum beyond the visible spectrum, whose colours, could the eye be trained to appreciate them, would be lighter tints of the lower colour. This spectrum would then begin with a paler, shriller, higher red, which we actually have in the lavender. The next, which will probably some day be rendered visible, would be a paler, shriller, higher orange; and so on through the yellow, green, and the other colours.

The analogy of the less rapid vibrations requisite to produce sound is in strict accordance with these considerations. Take, for instance, the note C of the natural gamut; it requires for its production, say 128 vibrations per second; if we increase the rapidity of the vibrations to 144, we get the next higher note, or D; at 160 vibrations, E; at 170⅔, F; at 192, G; at 213⅓, A; at 240, B; and at 256, or just twice the number of vibrations requisite to produce C, we get a higher note, which we call C', which though it differs from C in its pitch, and probably in its *timbre*, still bears to it in many respects a striking resemblance.

The visible range of coloured notes also constitute one octave, viz—red, corresponding, say, to C; and then orange, yellow, green, blue, indigo, and violet, corresponding respectively to D, E, F, G, A, and B. The octave, or the lavender, corresponding to C', can only be appreciated by the eye under favourable circumstances.

It is most probably more than a mere coincidence that the interval between the lower and the higher red, which is ½, is exactly the same as the interval between the higher and the lower C. Indeed, calculations we have made show a remarkable similarity in the intervals between the different colours of the spectrum, and the notes of the natural gamut with which we have compared them.

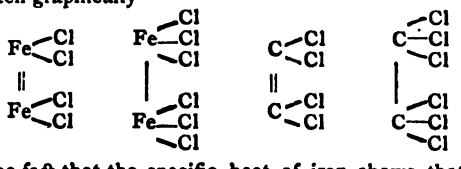
The same reasoning applies to the colours of the spectrum beyond the red, on the heat side, the next colour to which, could it be appreciated by the eye, would probably be a very dark reddish-violet, or a purple. In confirmation of this view, we have noticed that some reds, in turning into browns and blacks, possess a slight tinge of purple.

CORRESPONDENCE.

VALENCY OR ATOMICITY.

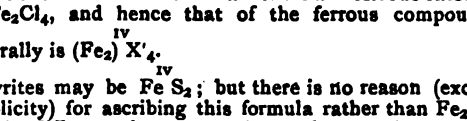
To the Editor of the Chemical News.

SIR,—Your correspondent "W. H. O." will find that the question of the apparently variable valency of iron has been discussed by Wurtz,* who adopts Friedel's hypothesis, that this metal is a tetrad ($\overset{IV}{Fe}=56$). Until the vapour density of ferrous chloride be correctly determined, it cannot be said with certainty whether the molecular formula of this compound is $Fe''Cl_2$, or $(\overset{IV}{Fe_2})Cl_4$, or $(Fe_n)^{2n}Cl_{2n}$; the vapour density of ferric chloride, however, shows that the molecular formula of this substance is $(\overset{VI}{Fe_2})Cl_6$. By assuming that iron is tetravalent, these two chlorides become precisely analogous to the similar carbon chlorides, $(\overset{IV}{C_2})Cl_4$ and $(\overset{VI}{C_2})Cl_6$; written graphically—



The fact that the specific heat of iron shows that its atomic weight is 56 is no proof that ferrous chloride does not contain *two* atoms of iron: when carbon and hydrogen combine (by the electric spark), the resulting hydrocarbon contains *two* carbon atoms, being acetylene; when chlorine acts on excess of copper, the product is cuprous chloride, Cu_2Cl_2; and, similarly, when nitric acid acts on excess of mercury, the resulting substance is mercurous nitrate, $Hg_2(NO_3)_2$. By analogy, therefore, it may be predicted that the molecular formula of ferrous chloride is Fe_2Cl_4, and hence that of the ferrous compounds generally is $(\overset{IV}{Fe_2})X'_4$.

Pyrites may be $\overset{IV}{Fe}S_2$; but there is no reason (except simplicity) for ascribing this formula rather than Fe_2S_4: and the difference between pyrites and marcasite may be expressed by the two formulæ:—



&c., &c.

* "Leçons de Philosophie Chimique," p. 160. Paris, 1864.

Wanklyn has suggested that oxygen (=16), as usually met with in combination, may really be a double atom; thus, if $O = 8$, and O be divalent, water may be written $H_2(O_2)''$, or graphically—

H—O—O—H or H—$(O_2)''$—H,

the double atom of oxygen being as inseparable, ordinarily, as the Fe_2 in the ferric compounds or the C_2 in the ethyl series. Carbon oxide, however, may be viewed as containing oxygen not in this form, but as single atoms; graphically, this may be written—

$$C\overset{=O}{=O}$$

when the four combining tendencies of the carbon are all saturated.

An argument in favour of this view may perhaps be drawn from the behaviour of carbon oxide when gently heated in presence of certain metals—*e.g.*, iron, cobalt, nickel; at temperatures not much exceeding the range of the mercurial thermometer the gas is decomposed, an oxide of the metal being produced and carbon being set free.* Under the same circumstances, carbon dioxide is perfectly inert, although it oxidises the metal at a red heat and upwards; from which it would appear as though the oxygen were in different conditions in these two gases respectively.

With respect to the abnormal oxides of nitrogen, Playfair and Wanklyn have shown† that, under certain conditions, nitrogen tetroxide has a vapour density corresponding with the molecular formula N_2O_4; but at higher temperatures, or under different conditions, the density is only one-half this, indicating the formula NO_2. Apparently, therefore, a dissociation takes place; with nitric oxide, however, the larger vapour density has not yet been observed, *i.e.*, the gas as ordinarily met with is in this dissociated condition.

The following modification of Wanklyn's hypothesis of the double atom of oxygen is capable of accounting simply for all these observed facts and apparently abnormal valencies:—*Oxygen is a triad, and has the atomic weight* 8. Ordinarily, however, a double atom is met with, which is a diad, and has the atomic weight 16; denoting the single atom by the symbol $\omega''' = 8$, we have—

$$O'' = (\omega_2)'' = \begin{matrix} -\omega \\ \| \\ -\omega \end{matrix}.$$

The molecule of free oxygen, therefore, like the precisely analogous one of phosphorus, contains four atoms, being $O_2 = \omega_4$. The following formulæ show how this view accounts for the abnormal nitrogen oxides and for carbon oxide; thus we have—

Ultimate atom of oxygen .. .. ω''' = 8

Ordinary double atom of oxygen $\omega_2'' = \begin{matrix} -\omega \\ \| \\ -\omega \end{matrix}$ = O = 16.

Molecule of free oxygen .. .. $\omega_4 = \begin{matrix} \omega\text{—}\omega \\ \| \quad \| \\ \omega\text{—}\omega \end{matrix}$ = O_2

Ozone .. .. $\omega_6 = \begin{matrix} & \omega & \\ / & \| & \backslash \\ \omega & & \omega \\ \| & & | \\ \omega & & \omega \\ \backslash & \| & / \\ & \omega & \end{matrix}$ = O_3

Water .. .. $\begin{matrix} H\text{—}\omega \\ \| \\ H\text{—}\omega \end{matrix} = \left.\begin{matrix} H \\ H \end{matrix}\right\} O$

Carbon oxide .. .. $C \begin{matrix} =\omega \\ | \\ =\omega \end{matrix}$ = C'' = O

Carbon dioxide .. .. $C \begin{matrix} /\ \omega \\ -\omega \\ -\omega \\ \backslash\ \omega \end{matrix}$ = $C^{IV} = O$ / = O

Silver quadrantoxide .. .. .. $\begin{matrix} Ag\text{—} \\ Ag\text{—}\omega \\ Ag\text{—} \\ Ag\text{—}\omega \end{matrix}$ = Ag_4O

In the nitroxygen series (assuming nitrogen to be trivalent)—

Nitrous oxide .. .. $\begin{matrix} N=\omega \\ | \quad | \\ N=\omega \end{matrix}$ or $\begin{matrix} N\text{—}\omega \\ \| \quad \| \\ N\text{—}\omega \end{matrix}$ = N_2O

Nitric oxide (hypothetical) .. .. .. $N_2\omega_4$ = N_2O_2

Dissociates into .. .. $N'''\omega''' + N'''(\omega_3)'''$ or $N{\equiv}\omega + N\begin{matrix} \omega \\ \cdot\cdot \\ \omega \\ \cdot \\ \omega \end{matrix}$

Nitrogen tetroxide at low temperatures .. $N_2\omega_8$ = N_2O_4

At higher temperatures dissociates into .. $N'''(\omega_3)''' + N'''(\omega_5)'''$. or $N\begin{matrix} \omega \\ \cdot\cdot \\ \omega \\ \cdot \\ \omega \end{matrix}$ + $N\begin{matrix} \omega\text{—}\omega \\ \cdot\cdot \quad \| \\ \omega\text{—}\omega \end{matrix}$

The vapour densities, and even the existence, of the other two members, N_2O_3 and N_2O_5, are not as yet known with certainty.

The tendency of nitric oxide to take up a molecule of oxygen and pass into nitrogen-tetroxide may be readily explained by supposing that the dissociated group $N{\equiv}\omega$ passes into $N{\equiv}(\omega_5)$ by taking up ω_4, the group $N(\omega_3)$ remaining unaltered, thus:—

$$N{\equiv}\omega + \begin{matrix} \omega\text{—}\omega \\ \| \quad \| \\ \omega\text{—}\omega \end{matrix} = N\begin{matrix} \omega\text{—}\omega \\ \cdot\cdot \quad \| \\ \omega\text{—}\omega \end{matrix}$$

This view of the constitution of oxygen may be applied to other elements: thus nitrogen itself as usually found in combination may be viewed as a complex of three atoms, each of which is triatomic and has the atomic weight $\frac{14}{3} = 4\frac{2}{3}$.

Hence, nitrogen may be trivalent or pentavalent; thus, denoting the ultimate atom by the symbol $\nu''' = 4\frac{2}{3}$, we have—

Ultimate atom .. .. $\nu''' = 4\frac{2}{3}$.

Nitrogen in triad compounds .. $(\nu_3)''' = N''' = 14$

Thus, ammonia .. .. .. $\left.\begin{matrix} H\text{—}\nu \\ | \\ H\text{—}\nu \\ | \\ H\text{—}\nu \end{matrix}\right\} = \left.\begin{matrix} H \\ H \\ H \end{matrix}\right\} N'''$

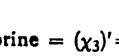
Nitrogen in pentad compounds $(\nu_5)^{v} = N^{v} = 14$

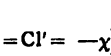
Thus, ammonium chloride $\left.\begin{matrix} H & \nu & H \\ H & | & H \\ Cl & \nu & = Cl \\ H & | & H \\ H & \nu & H \end{matrix}\right\} N^{v}$

In a similar way, chlorine, bromine, and iodine may be considered, ordinarily, as complexes of three atoms, thus:—

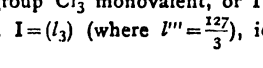
* I. Lowthian Bell. *Journal of the Iron and Steel Institute* (1871) p. 158 *et. seq.*

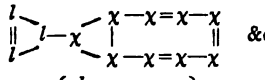
† *Journal of the Chemical Society*, vol. xv., p. 156.

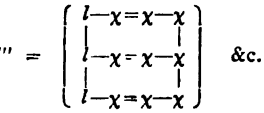
Chlorine = $(\chi_3)' = Cl' =$  usually monad.

Hydrochloric acid = $H(\chi_3)' = H-$  where $\chi''' = \frac{35{\cdot}5}{3}$

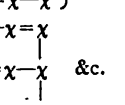
In iodine trichloride, ICl_3, either the I is monovalent, and therefore the group Cl_3 monovalent, or I is polyvalent; thus, when $I = (l_3)$ (where $l''' = \frac{127}{3}$), iodine trichloride may be—

$(l_3)'(\chi_9)' =$  &c.

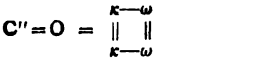
$(l_3)'''(\chi_9)''' =$  &c.

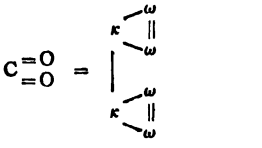
or $(l_3)^{v}(\chi_9)^{v} =$  &c.

It is evident that all the artiad elements may similarly be considered as practically inseparable complexes of trivalent atoms. Thus carbon may be $(\kappa_2)''''$ where $\kappa''' = 6$; Brodie's graphon then would be $\kappa_6 = C_3 = 36$ (Wurtz).

Marsh-gas $\overset{IV}{C}H_4 =$ 

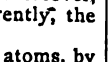
On this view, carbonic oxide may be accounted for without assuming a variation in the valency of the oxygen complex atom, thus:—

$C''=O =$ 

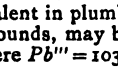
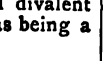
$C\overset{=O}{=O} =$ 

The fact that no other compound corresponding to carbon oxide (*e.g.*, methylene) has yet been prepared (although many such attempts have been made) tends to show that the variation in valency in this compound is due to the oxygen rather than to the carbon; moreover, the quadrantoxide of silver necessitates, apparently, the possible tetravalency of oxygen.

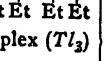
Evidently this view of the existence of triad atoms, by a combination of which are produced the complexes (ordinarily termed atoms) of which chemical compounds are made up, might be extended to all elements. Thus lead, which is tetravalent in plumbic ethide and divalent in its ordinary compounds, may be considered as being a complex of (Pb_2) where $Pb''' = 103{\cdot}5$, thus:—

Plumbous chloride | Plumbic ethide 

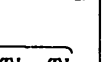
Similarly, thallium may be regarded as a complex (Tl_3) where $Tl''' = \frac{203}{3}$.

Thallous chloride  | Thallic chloride 

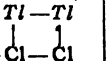
Until, however, the vapour densities of the metallic chlorides, &c., be obtained, it is impossible to say that some of these compounds have not double the molecular formulæ usually attributed to them: *e.g.*, plumbous chloride may be—

$(\overset{IV}{Pb} = 207)$ 

instead of $Pb''Cl_2$; and thallous chloride—



instead of $Tl'Cl$; thallic chloride being—



where $Tl''' = 203$.

Hence, at present it is unnecessary to extend this hypothesis to all elements—oxygen, nitrogen, chlorine, and their respective congeners being probably the only ones for which it is required in the present state of our knowledge, and even then only in special cases in the instances of the oxygen and chlorine series.—I am, &c.,

CHARLES R. A. WRIGHT, D.Sc.

Chemical Laboratory, St. Mary's Hospital, W.,
October 2, 1871.

THE "DIAMOND MATRIX."

To the Editor of the Chemical News.

SIR,—I beg to inclose you photograph* of a most interesting and rare geological specimen which was discovered on the Diamond-fields ("Du Toit's Pan.")

It consists of some hundreds of diamonds cemented to a core of foreign substance. Amongst the mass there appear garnets and other bodies. The weight of the entire specimen is 19 carats, and the photograph is a magnificent image 3¼ times (lineal).

As I hope to be in England about the middle of November, controversy, which is here rife as to its constitution, formation, &c., will, I trust, be set at rest by a full examination and analysis in London of the substances in combination with the gems.

I have several valuable minerals from South Africa, and a vast fund of information regarding the newly discovered diamond-fields, which I must reserve for a time, and hope to lay many subjects of importance before the Chemical Society on my arrival in England.—I am, &c.,

T. W. TOBIN.

Cape Town, South Africa,
September 1, 1871.

VITALITY OF DISEASE GERMS.

To the Editor of the Chemical News.

SIR,—Your correspondent, Richard Weaver (CHEMICAL NEWS, vol. xxiv., No. 619), states, that by his experiments, 350° is the highest temperature which may be used for disinfecting clothing, &c., by heat, without destroying the fabrics.

Dr. Calvert (in previous numbers) in his paper says, that at 400° germ life cannot exist, but I take it that his experiments were conducted at 100°, 200°, 300°, 400°, 500°, and 600° F. only, and that the intermediate temperatures were not tried. If this is the case, it might happen that even at 330° F. germ life will be destroyed, which will consequently render disinfection by heat practicable.

Not having the time or apparatus to repeat Dr. Calvert's experiments myself, I take the liberty of mentioning this. —I am, &c.,

H. B. YARDLEY.

Hudson's Wharf, Victoria Docks,
October 17, 1871.

* The photograph can be seen at our office by anyone interested in the subject.—*Ed. C.N.*

MISCELLANEOUS.

London Institution.—The first Evening Lecture of the session 1871-72 will be delivered on Thursday, November 2, at half-past seven, by J. H. Gladstone, Ph.D., F.R.S., F.C.S. Subject:—"Michael Faraday: the Story of his Life."

Quality of the Gas Supplied to London.—Dr. Letheby, the Chief Gas Examiner appointed by the Board of Trade, has recently reported to the Corporation of London, and to the Metropolitan Boards of Works, on the quality of the gas supplied to London by certain companies during the quarter which ended on the 30th of September last, from which it appears that the following is the average illuminating power of the gas of each of the Companies at the several testing places. When burnt at the rate of 5 cubic feet an hour, the common gas of the Chartered Company has been equal to 16·64 standard sperm candles at Arundell Street, Haymarket; to 16·84 candles at Gray's-Inn Road, to 17·50 candles at Friendly Place, Mile End; and to 17·59 candles at Cannon Street in the city. The Imperial Company's gas has been equal to 15·73 standard sperm candles at Camden Street; to 16·45 candles at Graham Street; and to 17·06 candles at Oakley Square; and the South Metropolitan Company's gas has been equal to 16·16 candles at the testing place at Hill Street, Peckham. The Cannel gas supplied by the Chartered Company to Cannon Street has been equal to 27·92 standard sperm candles, and at Arundell Street, Haymarket. And with respect to purity, Dr. Letheby reports that the gas of all the companies has been constantly free from sulphuretted hydrogen, except on two occasions, when traces of this impurity were present in the gas of the South Metropolitan Company, but he ascertained from investigations at the works that it was due to accidental circumstances. Sulphur in other form than this was present in the gas of the several companies in very variable proportions. In the Chartered gas (common) it amounted to an average of 29·24 grains per 100 cubic feet of the gas at Gray's-Inn Road; to 30·45 grains at Arundell Street; to 27·97 grains at Cannon Street, and to only 16·21 grains at Friendly Place. In the Imperial Gas it averaged 33·30 grains per 100 feet at Oakley Square; to 26·68 grains at Graham Street, and to 24·37 grains at Camden Street, and in the South Metropolitan gas it averaged 30·12 grains per 100 cubic feet. The Cannel gas of the Chartered Company at Arundell Street contained 25·65 grains per 100 feet, whereas the same description of gas at Cannon Street contained only 9·51 grains of sulphur. Dr. Letheby reported that, in most cases, the proportion of sulphur had been larger during the quarter than in the corresponding quarter of last year. Ammonia was not in any case in excess of the quantity prescribed by the referees.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, July, 1871.

The following original papers relating to chemistry are published in this number:—

New Method of Preparing Chloride of Antimony, and Production of an Oxide of Antimony Uncontaminated with Arsenic.—Dr. Rieckher.—The preparation of an oxide of antimony (for medicinal use) quite free from arsenic, and without the evolution of noxious gases, is obtained by treating antimony (metal) with twice its weight of oxide of iron and ten times its weight of crude hydrochloric acid. The neck of the retort wherein the operation is carried on should be connected with the receiver, which renders the use of any lute which might be acted upon by hydrochloric acid unnecessary. The mixture is to be kept boiling for several hours, whereby not only the metal is dissolved but also any arsenic it might contain removed. The receiver should be placed in cold water, a sufficient precaution to condense any hydrochloric acid gas which is evolved.

Sulphuric Acid a Product of the Combustion of Coal-Gas.—Dr. A. Vogel.—The author records a series of experiments made to prove the well-known fact that sulphuric acid is a constant product of the combustion of coal-gas, even when purified as perfectly as possible from sulphuretted hydrogen; the source whence the sulphuric acid is derived is the sulphide of carbon present in the gas.

Detection of Minute Traces of Manganese.—Dr. Böttger.—A few grammes of chemically-pure chlorate of potassa are first fused in a test-tube, and, while fused, there is put into it a minute quantity of the substance, mineral or organic, to be tested for manganese. If at the end of the reaction the contents of the thoroughly-cooled tube exhibit a peach-blossom red colour, the substance thrown into the fusing chlorate of potassa contained manganese, the presence of which may be thus ascertained in wood, human hair (especially the reddish coloured), coal, and minerals, of all of which only minute quantities are required.

Mixtures for Keeping Furs, Woollen Fabrics, and Carpets from being Injured by Moths.—Dr. Vorwerk.—Take:—Pure carbolic acid, 45·0 grms.; camphor and oil of rosemary, each, 30 grms.; oil of cloves and aniline, each, 5 grms.; dissolve these substances in methylated spirits, 2·5 litres. Pure carbolic acid, 20·0 grms.; camphor, oil of cloves, oil of lemon-rind (*Ol. citri cort.*), nitrobenzol, each, 10 grms.; aniline, 2·5 grms.; dissolve in methylated spirits, 1·5 litres. These fluids are applied to the fabrics and furs by the aid of the so-called *pulverisateurs*, spray-producers. The operation if properly done will only be required to be repeated twice or, at most, three times a year. Since these mixtures are inflammable, the operation with the *pulverisateur* should only be performed by daylight. No goods nor colours are injured by exposure to the spray.

August, 1871.

This number contains the following papers relating to chemistry and collateral sciences:—

Action of the Water Air-Pump, its Application to Boiling, Evaporation, Distillation, Filtration in Vacuum, and for Drying Herbs and Crystals.—F. A. Wolff.—The contents of this valuable essay are not suited for abstraction, as it would involve the reproduction of a series of woodcuts.

Analysis of the Water of the "Karlsbrunnen," at Nauheim (Prussia, Hessen).—Dr. Uloth.—Sp. gr. of the water at 15° = 1·00895; 1000 grms. contain:—Carbonate of lime, 0·6608; carbonate of protoxide of iron, 0·0110; carbonate of protoxide of manganese and of zinc, of each a trace; sulphate of strontia, 0·0087; sulphate of lime, 0·2277; chloride of ammonium, 0·0113; chloride of potassium, 0·0731; chloride of lithium, a trace; chloride of sodium, 9·860; chloride of magnesium, 0·2040; chloride of calcium, 1·0578; bromide of magnesium, 0·0014; arsenite of protoxide of iron, a trace; phosphate of protoxide of iron, 0·002; silica, 0·0087; nitric acid and organic matter, of each a trace; sum of fixed salts, 12·1247; partly-combined carbonic acid, 0·2949.

Zeitschrift für Chemie von Beilstein, No. 10, 1871.

This number contains the following original papers and memoirs:—

Synthesis of Piperonylic Acid and New Mode of Formation of Protocatechu-Aldehyde.—R. Fittig and I. Remsen.—After referring to some other researches bearing upon this subject, the authors state that they have made a mixture of 1 molecule of pure protocatechutic acid, 3 mols. of hydrate of potassa, and 1½ mols. of methylen-iodide, which has been put into a tube and, after sealing, the latter has been exposed for several hours to a temperature of 140°; the contents of the tube having been submitted to a lengthy and tedious process of purification yielded a methylen-protocatechutic acid which was found to be in physical as well as chemical properties identical with piperonylic acid. This experiment proves, therefore, that the acid just named is methylen-protocatechutic acid; as regards the constitution of piperic acid it is observed that it contains the group—

$$-O \\ -O > CH_2.$$

Ethylen-Protocatechutic Acid.—R. Fittig and T. Macalpine.—By causing protocatechutic acid, ethylen-bromide, and caustic potassa to react upon each other in a sealed tube, the authors obtained the ethylen-protocatechutic acid—

$$C_6H_3 \begin{matrix} -O \\ -O \\ -CO.OH \end{matrix} > C_2H_4,$$

a body soluble in water and alcohol, very similar to piperonylic acid, fuses at 133°, sublimes at a higher temperature unaltered.

The Aldehyde of the Naphthaline Group.—J. Battershall.—The aldehyde of naphthoë acid, $C_{11}H_8O = C_{10}H_7.CHO$, is prepared by the distillation of a mixture of naphthoëate of lime and formiate of lime. The purified aldehyde is a colourless somewhat thickish fluid, heavier than water, boiling at 280°.

Benzol-Hexachloride.—Z. Heys.—The author has prepared this body, originally discovered many years ago by Prof. Mitscherlich, by

passing a current of chlorine into benzol for several days consecutively The substance alluded to is solid, soluble in alcohol, crystalline, fuses at 157°. It appears that this hexachloride of benzol has very great stability, since it is not acted upon by boiling either with nitric or with nitro-sulphuric acids.

Action of Fusing Caustic Potassa upon Sulphoxybenzoic Acid.—I. Remsen.—This paper and the two following by the same author are written solely for the purpose of vindicating the correctness of his researches against the imputations published thereupon in other periodicals.

Isomeric Sulpho-Salicylic Acids.

Oxidation of Toluol-Sulpho Acids.

Researches on the Derivatives of β-Para-Brom-Sulpho-Toluol.—F. C. G. Müller.—The amide of the ortho-toluol-sulpho acid fuses at 91°, is crystalline, soluble in water. Nitro-β-para-brom-toluol-sulpho acid is readily soluble in water, alcohol, and ether, crystalline, deliquescent; the acid and its salts are very bitter to the taste.

Nature of Sulpho- and Sulpho-Nitro-Bibrom-Benzol.—R. D. Williams.—The catalogical description of a series of salts belonging to sulpho-bibrom-benzol and bibrom-nitro-sulpho-benzol.

On Brom-Sulpho-Toluol.—H. Hübner.—A short preliminary notice on this subject; a full account will be given hereafter.

Conversion of Allylic Alcohol into Acrylic Acid.—B. Tollens.—Pure bromide of allylic alcohol yields by oxidation an acid, $C_3H_4Br_2O_2$. This acid was treated with zinc-dust, and the result of that reaction again with sulphuric acid, whereby acrylic acid was obtained. The formation of acrylic acid from an acid, $C_3H_4Br_2O_2$, is akin to the formation of the first-named acid from propionic acid; it is also a proof which confirms the following formulæ:—

CH_2	CH_2Br	CH_2
‖	|	‖
CH	$CHBr$	CH
|	|	|
CH_2OH	$COOH$	$COOH$
Allylic alcohol.	Bibrom-propionic acid.	Acrylic acid.

Action of Chloral upon Aniline.—O. Wallach.—Preliminary notice.

Electro-Thermo-Chemical Experiments.—Dr. E. Mulder and F. C. E. von Embden.—This excellent paper, being illustrated with woodcuts, does not admit of any useful abstraction.

New Edition of a Highy Valuable Work.—MM. Friedrich Vieweg and Son, at Brunswick, announce the publishing of a new edition of the well and deservedly known "Handwörterbuch der Chemie," under the title "Neues Handwörterbuch der Chemie," based upon that edited by Drs. Liebig, Wöhler, Poggendorff, Kolbe, and Fehling; the last-named of these *savants* is the editor of the new edition, with the co-operation of Drs. Bunsen, Fittig, Fresenius, v. Gorup-Besanez, Hofmann, Kekulé, Kolbe, Strecker, Wichelhaus, and others.

Les Mondes, September 28, 1871.

Exploration of the Baltic Sea.—Rev. F. Moigno.—The short and as yet preliminary account of a journey made by the Imperial German steamship *Pommerania*, for the express purpose of making a thorough survey of the sea alluded to. It appears that the greatest depth, 240 metres, is met with between the island of Gothland and the Courland coast; notwithstanding it was in the middle of July, the temperature of the water at this depth was only from 0·5° to 2° R. No marine plants were found at this depth, and animal life was only represented by two species of worms; the water at this depth and locality contains only a small quantity of salt in solution. At a less depth, 100 metres, there are animals living, and in the more shallow portions of this sea plants also vegetate.

Talpa Marina.—M. Toselli.—The description of some experiments made with a very ingenious contrivance, which may be briefly stated to be a greatly improved diving-bell, which has been tried at Baja, near Naples. This apparatus can acccommodate two persons, has an air-vessel with strongly-compressed air attached for the requirements of respiration, telegraphic apparatus for communication with the shore or vessel from which the *talpa* is lowered under water, and an arrangement also by which, without being drawn up, the machine may reach the surface of the water and float.

Extraordinary Meteor Seen at Marseilles.—Dr. Coggia.—On August 1 last, at 10.43 p.m. Marseilles mean time (5° 22′ 19″ E. of London), the author observed a large blood-red coloured meteorite, which moved slowly in a direction first west and next north, having been lost sight of at 11° 3′ 28″ p.m. The diameter (apparent) was about 15′ at first, but decreased to 0·4′. Before being lost sight of, this meteorite appeared to emit incandescent sparks.

Nomenclature of the Textile Fibres in Common Use.—Rev. F. Moigno.—Under this title the excellent *savant* calls attention to a scientific educational institute established at Melle-Lès-Gand, Belgium, which establishment, according to the few lines devoted to it here (the author recently paid it a visit), is one of the best arranged and most complete industrial-commercial schools to be met with anywhere, the museums, library, laboratories (chemical, physical, and mechanical), cosmographic, numismatic, and other collections being in every respect complete and up to the latest improvements and discoveries. It appears, further, that the teachers are not only men of high acquirements, but actively engaged in diffusing through the press useful knowledge, and part thereof is the publishing of the nomenclature of 550 plants utilisable for the purpose of rope-, cordage-, and paper-making, spinning, and weaving, &c.; to the name of each plant (inclusive of those names in use in several Asiatic and other foreign dialects) are given all the synonyms, with every information required for travellers, naturalists, and parties connected with industry. The article here alluded to contains a specimen reproduction of this work, which is in the press.

La France Scientifique (*Ancien Cosmos*), September 24, 1871.

The editor of this periodical, Dr. V. Meunier, has chosen as motto for his new paper:—"Régénerer la France par la Science et la Science par la Liberté." We think, judging from the contents of this number, that the editor has taken a really sensible and correct view of matters, which it would be bad taste on our part to enter into details upon here, but which, if duly carried into practice, will certainly tend best to regenerate France, and, with the "Fluctuat nec Mergitur" of the ancient coat of arms of Paris borne in mind, we sincerely hope that millions of Frenchmen will acknowledge the correctness of the author's views, and firmly united together, bearing in mind the "Bene juncti valemus pauci," achieve great things in the pursuits of peace (science, arts, industry, agriculture, and commerce), and make the Tricolore Français respected and esteemed all over the globe.

Le Moniteur des Produits Chimiques pour l'Industrie, les Sciences et les Arts et du Matériel de ces Industrie Publié par une Société de Chimistes et d'Industriels, September 25, 1871.

Pigments and Dyes Known to and Used by the Ancients.—E. Rousset.—The continuation of this paper (see CHEMICAL NEWS, vol. xxiv., p. 134). It appears that the Ancients used the following yellow pigments:—Ochre, massicot, orpiment, and realgar; the latter are poisonous, and do not cover well; the former are devoid of any brilliancy. As to the yellow dyes used by the Ancients nothing is positively known, but it seems that woad, saffron, and other native plants were employed. Referring to yellow pigments discovered by modern chemistry, Naples yellow (antimoniate of lead), mineral yellow (oxychloride of lead), and the chromium colours, discovered by Vauquelin (1797), cadmium yellow, discovered by Stromeyer (1817), are mentioned. Among the modern yellow dyes, purrhee and picric acid are enumerated. Vermillion, red ochres, and minium were known from a remote antiquity, though neither Greeks nor Romans were acquainted with the artificial preparation of vermillion, which has been known to the Chinese for a very lengthy series of centuries past. As to red dye-stuffs, there can be no doubt that madder was known and used not only for dyeing fabrics but also in the shape of so-called lake. Kermes, a dye-stuff little known in this country but yet used in France, was known to and used by the Ancients, being undoubtedly already used in Egypt *tempore* Moses. Among the green paints the Ancients were only acquainted with some native green-coloured compounds of copper, and with the acetates of that metal; the number of green pigments discovered in modern times is very large, and need not be here alluded to. Of purple dyes known to and used by the Ancients, the celebrated Tyrian purple is here at length spoken of. Among the molluscs from which this dye was obtained is the *Janthina prolongata*, yet found in the Mediterranean, and a very common object in that sea near Narbonne (in this very ancient city there were Tyrian purple dye-works at least 600 years B.C.), where in our days some experiments have been made by Dr. Lesson which really prove that the mollusc just named yields, though only in very small quantity, an exceedingly beautiful purple. Dr. Bancroft was also acquainted with this fact, and made several trials for the purpose of ascertaining whether this dye-stuff might be again industrially applied.

Researches on Lydine.—P. Guyot.—A very beautiful violet colour known under the name just mentioned is prepared as follows:—Take 100 grms. of aniline, and dissolve it in 100 grms. of hydrochloric acid previously diluted with 120 c.c. of distilled water; pour this solution into a solution of red prussiate (ferricyanide of potassium) made of 90 grms. of the salt dissolved in 850 c.c. of water. The mixture is next boiled for an hour and a half, and then cooled.

Manufacture of Fatty Acids.—M. Bodisson.—The author has invented a process, not clearly described in this short notice—from which we only learn that a high temperature (300°) and a vacuum, at least exclusion of contact of air, are employed—by the application of which purer fatty acids and a greatly increased quantity (88 per cent from the tallow used) are obtained.

Polytechnisches Journal von Dingler, first number for September, 1871.

The following original papers relating to chemistry and collateral sciences are published in this number:—

Galvanic Battery (Tauch Batterie).—MM. Keiser and Schmidt.—The description of an improved galvanic battery, but requiring the aid of engravings for proper elucidation.

Continuation of the Essay on the Blast Furnaces.—C. Schinz.—The headings of the sections of this portion are—Capacity of furnace; economic conditions; means for saving fuel; use of coal as fuel.

Quantitative Estimation of Nitric Acid.—Dr. A. Wagner.—After briefly referring to a former communication on this subject (see CHEMICAL NEWS, vol. xxiii., p. 261), the author now describes another process, based upon the decomposition of the nitrate at a high temperature, and calculating from the quantity of deutoxide of nitrogen the amount of nitric acid. The experiment is carried on as follows:—In a combustion-tube of hard glass is placed, first ½ grm. of bicarbonate of soda, next the mixture of nitrate of potassa (about ½ a grm.) with chromic oxide and carbonate of soda. A gas conducting-tube is fastened by means of a perforated cork, the tube being placed in a furnace; that portion of it wherein the bicarbonate of soda is placed is first gently heated, so as to expel all air. The ignition to

bright redness of the portion of the tube containing the nitrate mixture is then proceeded with, and the gas collected in a graduated tube of at least 300 c.c. capacity, and standing in a mercury trough being partly filled with that metal, partly with a known quantity of a dilute titrated solution of caustic soda, while also 100 c.c. of pure oxygen occupy the upper part of the tube. The regenerated nitric acid is absorbed by the caustic soda, and this at the end of the operation titrated with dilute sulphuric acid. It is clear that an excess of oxygen is required, that the bicarbonate of soda has to be heated a second time to expel any remaining deutoxide of nitrogen, and that after the combustion has ceased the glass cylinder has to remain in the mercury trough for some time, and the contents of the cylinder gently shaken, so as to obtain a perfect reaction.

Estimation of the Non-Permanent Hardness of Water.—Dr. A. Wagner.—Reserved for full translation.

On some Applications of Sulphide of Carbon.—H. Haedicke.—This paper treats on the use of sulphide of carbon for the extraction of oils and fat by means of peculiarly-constructed apparatus, the arrangement of which is illustrated by engravings.

A Calorimeter.—H. Rheineck.—Illustrated with a woodcut.

Influence Exerted by Secondary Extract Formation in Fermenting Wort.—Dr. W. Schulze.—This lengthy essay bears entirely upon the particular subjects of brewing and grain-spirit producing.

Annual Consumption of Beer per head of Population in the Undermentioned Countries.—Dr. Dingler.—Bavaria, 80 maasz (= 1·069 litre each maasz); England, 74; Belgium, 51; Würtemberg, 40; Austria, 16; France, 13; Switzerland, 12; Prussia, 10. While 7·5 per cent of the entire revenue of the United Kingdom is derived from the beer (malt) tax, this amounts, for Bavaria, to 15·5 per cent; for Austria, 2·9 per cent; France, 1·9 per cent; Prussia, 1·2 per cent.

Journal für Gasbeleuchtung und Wasserversorgung, Nos. 17, 1871.

The contents of this number only bear upon subjects strictly relating to gas- and water-works' engineering and management.

La Revue des Scientifique de la France et de l'Etranger, September 23, 1871.

This number does not contain any original papers relating to chemistry, but we call attention to the two following memoirs:—

Different Methods of Observation Employed in Stratigraphic Geology.—Dr. Bleicher.—An excellent essay, illustrated by several engravings.

Association of Commerce and Industry of Roubaix.—M. Féron.—Under the title just quoted, this paper contains an account of a lecture on the sorting of the impurities of wool, the means of cleansing that textile fibre, and on spinning, weaving, and dyeing it.

Biography of the Late E. Lartet.—G. de Mortillet.—This paper records the labours and the published works of a celebrated geologist and palæontologist.

September 30, 1871.

This number does not contain any original papers strictly belonging to chemistry, but we quote the title of an excellent essay:—

Absorption of Gases by Organic Liquids.—Dr. Gréhant.—Illustrated by a series of woodcuts. This essay is a portion of the author's published lectures on experimental physiology.

NOTES AND QUERIES.

Cement to Resist Sulphuric Acid.—(Reply to H. R. Yardley.)—Take caoutchouc: melt this by a gentle heat, add from 6 to 8 per cent of the weight of tallow, taking care to keep the mass well stirred; add dry slaked lime, so as to make the fluid mass the consistency of soft paste; and, lastly, add 20 per cent of red lead, whereby the mass, which otherwise remains soft, becomes hard and dry. This cement resists, according to Dr. Wagner, boiling sulphuric acid. A solution of caoutchouc in twice its weight of raw linseed oil, aided by heating, and the addition thereto of an equal weight of pipeclay, yields a plastic mass which also resists most acids.

Electro-Deposition of Aluminium and other Metals.—I see it stated in your "Notes and Queries" that aluminium has not yet been deposited on other metals by the battery. For more than two years I have been depositing aluminium daily on iron, steel, and other metals, and driving it into their surfaces at a heat of about 500° F., in the same way as I do silver and nickel. Also I have been doing the same with the alloy of aluminium called aluminium bronze, of various tints, from the palest lemon to the richest gold colour. I also deposit occasionally platinum, but it would not stand on iron and steel if deposited from the solution named by your correspondent, nor, in fact, satisfactorily on any metal which is not neutral in that solution.—J. BAYNES THOMPSON, White Hall, Wraysbury, Staines.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 622.

A STUDY OF ALDEHYDE AND AMMONIUM COMBINATIONS.

By S. E. PHILLIPS.

Is there any evidence that certain hydrocarbons replace 2 atoms of hydrogen, others 3 atoms; and if so, would a tetra-atomic element or radical replace 4 atoms of H? I have looked with some amount of industry for many years at this problem, and now think that one of two things must subsist; either that the evidence is indeed very small, or such distinguished men as Berthollet and others, failing to see it, must have a vision distorted by preconceived hypothesis.

Admiring as I do the eminent abilities of the discoverer of sulph-urea, it is with much diffidence I moot, in regard to Mr. Reynolds's paper (CHEMICAL NEWS, vol. xxiv., p. 87) on this subject, that his point of view is contracted, and his main object in altering the formulæ presumptive.

More than twenty years ago I discovered, or pointed out, the "atmonia" type, or the doubly condensed ammonia of which urea is an illustration. I then assumed that wherever (CO) existed, (CS) might be found to replace it, but chemists held that the sulph-urea had no existence, until Reynolds realised the fact in such a masterly way as to command universal acceptance.

I now maintain that not only two aldehyde radicals (which he seems to deny) but three or more atoms may be introduced into the atmonial type, and that the two primary ureas alluded to involve no particular speciality to separate them from the vast generic group to which they belong. As a moot point for enquiry, I jot down a few particulars from the slender means just now at command.

Professor Andrews, as President of the Chemical Section of the British Association, has called attention to a group which associates ethylen with other monatomic bodies in a way that may be instructive herein; and in a paper on the Amides, referring to the hydramides, I have sought to trace analogies between ethylen or aldehyde and other aldehydes or aromatic oils, which, with ammonia, give corresponding atmonias (ureas).

3 Almond oil,	$3(C_{14}H_6O_2)+H_6N-6HO=C_{14}H_5\quad H_3,N_2$	
" Oil of ants,	$"(C_{10}H_4O_4)+\quad"\quad"\quad(C_{10}H_3O_2)H_3,N_2$	
" Cinnamon oil,	$"(C_{18}H_8O_2)+\quad"\quad"\quad(C_{18}H_7)\quad H_3,N_2$	
" Aniseed oil,	$"(C_{16}H_8O_4)+\quad"\quad"\quad(C_{14}H_7O_4)H_3,N_2$	
" Acetone	$"(C_6H_6O_2)+\quad"\quad"\quad(C_6H_5)\quad H_3,N_2$	
" Aldehyde,	$"(C_4H_4O_2)+\quad"\quad"\quad$ (?)	

By oxidation, the radical constituents of these hydramides pass into their acid forms, furfurine gives pyromucic acid $(C_{10}H_3O_2)O$, which crystallises in a form like benzoic acid out of amarine, &c.

Acetonine is a colourless alkaline liquid of urinous odour, of which I give two saltic forms: $(C_6H_5)_3H_4N_2Cl+PtCl_2$ and $(C_6H_5)_3H_4N_2O+2C_2O_3$.

Carbo-thiacetonine is probably—

$$(C_6H_5)_3(CS)_2H_2,N_2S+HS.$$

Baeyer's synthesis of picoline is instructive; 2 acrolein + ammonia = picoline—

$$2(C_6H_4O_2)+H_3N-4HO=(C_6H_3)_2H,N.$$

M. Schiff's synthesis of coniine is still more so, as derived from the distillation of butyraldine—

$$(C_8H_7)_2H_2NO+HO-2HO=(C_8H_7)_2H,N.$$

Shröder gives us derivatives of valeraldehyde, thus:—

$$C_{10}H_{10}O_2 \text{ and } C_{10}H_{10}S_2.$$

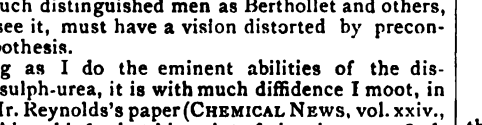
		Density.	Wt.	
Valeraldine	$=C_{30}H_{21}S_4,N$	144·5″	289	
Carbo-valeraldine	$=C_{28}H_{22}S_4,N_2$	60·8	246	$=(C_{10}H_9)_2(CS)_2H_2,N_2S+HS$
Valeraldehyde ammonia	$=C_{10}H_{13}O_2N$	52·16″	103	$=(C_{10}H_9)H_2,NO+HO$

The analogy between acetonine, carbo-thiacetonine, and carbo-valeraldine is close, and peradventure gives us the very substitution Reynolds assumes not to exist, and from which non-existence he deduces the alteration of type or structure. Divested of their saltic types they become—

Acetonine	$(C_6H_5)_3\quad H_3,N_2$
Carbo-thiacetonine	$(C_6H_5)_3(CS)_2H\ ,N_2$
Carbo-valeraldine	$(C_{10}H_9)_2(CS)_2H_2,N_2$
Aldehyde urea	$(C_4H_3)\ (CS)_2H_3,N_2$

		Original.	Altered.
Do. (Reynolds)	CS″	$\begin{cases}NCH_4''\\NH\end{cases}$	$\begin{cases}NCH_4''\\CSH\\NH\end{cases}$

It is no less amusing than instructive to compare these two forms with M. Schiff's notation of coniine—



I cannot understand what aldehyde-ammonia is, or thialdine, or the homologous 2-vol. valeraldin! If the 4 vols. rightly bespeaks a saltic type for carbo-valeraldine, then it may happen that the corresponding carbo-thialdine has been the very non-existent substance alluded to by Reynolds, viz.—

Carbo-valeraldine	$(C_{10}H_9)_2(CS)_2H_3,N_2S+HS$
Carbo-thialdine	$(C_4H_3)_2(CS)_2H_3,N_2S+HS$
Sinapoline	$(C_6H_5)_2(CO)_2H_2,N_2$
Thio-sinnamin	$(C_6H_5)\ (CS_2)H_3,N_2$

M. Arzruni gives some forms of sulph-ureas:—

$(C_{14}H_5O_2)$	$(CS)_2H_3,N_2$
$(C_{14}H_5O_2)(C_{12}H_5)$	$(CS)_2H_2,N_2$
$(C_{14}H_5O_2)_2$	$(CS)_2H_2,N_2$

M. Schiff gives some atmonial forms with all the H constituents replaced—

Sal-hydrethylanilide $(C_{12}H_5)_2(C_4H_5)_2(C_{14}H_5O_2)H,N_2$.
Ethyl-sal-hydranilide $(C_{12}H_5)(C_4H_5)(C_{14}H_5O_2),N$
Ethyl-sal-hydrethylanilide $(C_{12}H_5)_2(C_4H_5)_3C_{14}H_5O_2,N_2$
Copper sal-hydranilide $(C_{12}H_5)_2(C_{14}H_5O_2)_2Cu_2,N_2$.

It should be understood that I attach no particular value to the notations employed. I have simply followed Liebig and others in regard to well-established radicals in contradistinction to such as are now so rife in the multitudinous forms of modern notation. Sometimes I think the aromatic oils are hydrides, $C_{14}H_5O_2,H$; at others they seem better regarded as of weak alcoholic types, $C_{14}H_5O+HO$. The ideas intended herein are probably both right, but with the ever-increasing knowledge of isomeric variation, it is most unwise to affect precision where all is shrouded in impenetrable darkness.

NOTES OF DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

I.

ANIMAL tissues have ⅞ths of their weight as water; the percentage of ash varying, averaging 3·0 per cent. The elements in constitution of animals are about 17, some add Pb and As,—in all 19, viz., C, H, N, O, S, P, Cl, Fl, Ca, Mg, Al, K, Na, Fe, Mn, Cu, Si.

Metallic elements are best seen by spectroscopic demonstration after incineration of substance. The metals, with the exception of iron, are in the form of salts, as—

$$NaCl, Ca_3 2PO_4, \&c.$$

The elements occur in somewhat of the following order:—C, H, N, O, in most tissues; S in albumen; P in bone; Cl in juices as NaCl; in gastric juice as HCl; Fl and Si in teeth; the latter in bone also; Al, Ca, and Mg in teeth and bone; Na and K in blood; Fe in colouring matter of blood; Mn in hair; Cu in liver, bile, and gall-stones.

The non-metallic elements may be recognised as follows:—

C, by charring and formation of CO_2 when combusted; H, by formation of water; N, by heating with solid KHO and production of NH_3; S by combustion in pure $KClO_3$ is converted to K_2SO_4, test with $BaCl_2$; P, by similar treatment, test with $MgSO_4+NH_3$; Si by insolubility in acids; other elements are too indefinite to be recognised by simple testing.

These elements unite to form "proximate elements," which may be divided into two groups, nitrogenous and non-nitrogenous.

Albumen, with fibrin, casein, paralbumen, globulin, and vitellin, are the principle nitrogenous bodies, and have, according to Mulder, for their base a substance—protein, ($C_{18}H_{25}N_4O_5,H_2O$?)—which, he affirms, is free from sulphur, though hitherto it has not been so obtained.

It is worthy of remark that these compounds, which form the great bulk of our food, are richly charged with N. Albumen has a formula $C_{72}H_{112}N_{18}SO_{22}$, but in its soluble form is combined with Na, Gerhardt considering two atoms H displaceable, thus giving to white of egg the formula $NaHC_{72}H_{110}N_{18}SO_{22},H_2O$.

Soluble albumen is colourless, tasteless, glairy, and rotates to the left when polarised; evaporated at 50° C. it becomes a yellow, brittle, transparent mass; this, washed successively with alcohol, ether, and hydrochloric acid, to remove extract, fat, and salts, is pure albumen. Albumen coagulates at 60° C. The mineral acids, except trihydric phosphate, precipitate albumen; the organic acids, except tannic acid, do not precipitate it.

Alum, HgCl, $CuSO_4$, $Pb2C_2H_3O_2$, creasote, and alcohol, all precipitate albumen, but the most delicate test is potassic ferrocyanide in the presence of hydric acetate; HgCl detects 1-2000 in solution.

From the above data albumen is the best antidote for metallic salts when taken as poison. The S of albumen, during putrefaction, yields H_2S.

Protein is prepared by dissolving any albuminous body in KHO, and precipitating with hydric acetate. Hydric nitrate and protein produce xantho-proteic acid, a yellow inflammable body. Hydric chloride dissolves proteic compounds, producing a blue solution.

Protein and KHO, when boiled together, form carbonate and formiate of ammonia, leucin, &c.; boiled with H_2SO_4, leucin, tyroin, and other bodies are formed.

Albumen, boiled for some hours with water, is reduced to ammoniacal tritoxide of protein—

($H_3N,C_{36}H_{50}N_8O_{13},2H_2O$?)

Paralbumen, globulin, myosin, &c., are modifications of albumen.

ON THE

DETERMINATION OF SMALL QUANTITIES OF MANGANESE.

By THOMAS M. CHATARD.

The delicacy of Crum's test for manganese is well known, but it is believed that no attempt has hitherto been made to employ it as a method of quantitative determination. The following work was, therefore, undertaken with that view.

A standard solution of ammonic oxalate was prepared, of which 1 c.c. = 0·0005467 grm. Mn. A sample of dolomite was taken, and four portions were weighed out. These were dissolved in nitric acid, and a small quantity of plumbic peroxide added to each. On boiling, the bright colour of hypermanganic acid appeared. The solutions were passed through small filters of asbestos with the aid of a Bunsen's pump, and the hypermanganic acid was determined by means of a standard solution of ammonic oxalate, with the following results:—

Grm.		C.c.	Mn. Grm.	Mn. Per cent.
3·1300	dolomite required	39·0	= 0·0216	= 0·069
2·781	,, ,,	33·2	= 0·0181	= 0·065
2·0998	,, ,,	24·5	= 0·0134	= 0·063
1·8671	,, ,,	23·5	= 0·0128	= 0·062

Mean = 0·065 p. c. Mn.

In a sample of limestone from White Horse, Chester Co., Pa. the analysis showed—

Grms.		C.c.	Mn. Grm.	Mn. Per cent.
3·4316	required	120	= 0·0656	= 1·92
2·2809	,,	83·5	= 0·04564	= 2·00
4·0697	,,	153·5	= 0·0838	= 2·05

Mean = 1·99 p. c. Mn.

But the method, though giving good results, where the percentage of manganese is small, fails when any large amount of that metal is present. Well dried manganous pyrophosphate was treated with sulphuric acid, as nitric acid, though dissolving it was found not to decompose it, little or no hypermanganic acid being formed when the plumbic peroxide was added. With sulphuric acid, the red colour of hypermanganic acid was produced, but it was found that not even long boiling sufficed for total oxidation.

This was also the case with an alloy of iron and manganese. The longer it was boiled, the more hypermanganic acid was formed, but there seemed to be no definite limit. No concordant results having been reached, and a well marked end reaction in such cases being hard to obtain, the method as applied to general analysis was given up.

There seems to be, however, reason to maintain that when the quantity of manganese is very small, the method will be found both easy and accurate. Perhaps by some modification of the process, it may be made to apply also to the cases in which large quantities of manganese are present.

In conclusion, I desire to acknowledge my indebtedto Dr. W. Gibbs for his careful supervision and many valuable suggestions.—*American Journal of Science.*

ON THE

MICROSCOPICAL EXAMINATION OF DUST BLOWN INTO A RAILWAY CARRIAGE NEAR BIRMINGHAM.*

By JOSEPH SIDEBOTHAM, F.R.A.S.

On the 24th May, 1870, while travelling by rail between Saltley and Camp Hill, I spread a paper on a seat of the carriage near the open window, and collected the dust that fell upon it. A rough examination of this with the two-thirds power showed a large proportion of fragments of iron, and on applying a soft iron needle I found that many of them were highly magnetic. They were mostly long, thin, and straight, the largest being about 1-150th of an inch, and, under the power used, had the appearance of a quantity of old nails. I then with a magnet separated the iron from the other particles.

The weight altogether of the dust collected was 5·7 grains, and the proportion of those particles composed wholly or in part of iron was 2·9 grains, or more than one-half. The iron thus separated consisted chiefly of fused particles of dross or burned iron, like "clinkers;" many were more or less spherical, like those brought to our notice

* Read before the Manchester Literary and Philosophical Society.

by Mr. Dancer from the flue of a furnace, but none so smooth; they were all more or less covered with spikes and excrescences, some having long tails like the old "Prince Rupert's" drops; there were also many small angular particles like cast-iron, having crystalline structure.

The other portion of the dust consisted largely of cinders, some very bright angular fragments of glass or quartz, a few bits of yellow metal, opaque white and spherical bodies, like those described by Mr. Dancer, grains of sand, a few bits of coal, &c.

After the examination of this dust, I could easy understand why it had produced such irritation; the number of angular, pointed, and spiked pieces of iron, and the scoriæ or clinkers, being quite sufficient to account for the unpleasant effect.

I think it probable that the magnetic strips of iron are laminæ from the rails and tires of the wheels, and the other iron particles portions of fused metal, either from the coal or from the furnace bars. The large proportion of iron found in the dust is probably owing to the metal being heavier than the ordinary dust, and accumulating in cuttings such as those between the two stations named.

If I had to travel much by railway through that district, I should like to wear magnetic railway spectacles, and a magnetic respirator in dry weather.

After the reading of the paper, Mr. CHARLES BAILEY drew attention to some experiments which Mr. Charles Stodder, of Boston, U.S., had been making on the microscopic contents of the atmosphere of that city. Amongst other investigations he was led to examine a fine black dust from a beam in the polishing shop of the United States Armoury, at Springfield. He found it to contain a few vegetable fibres, some apparently organic fragments, and some broken crystals; but the great mass of it was made up of amorphous fragments of iron, of the 1-100 m.m. and upwards in size, as well as curved and irregular fibres and masses of iron with sharp jagged edges, from 5 to 15 m.m. in size; there were also some very minute perfect spheres, probably iron. In trying the effect of the magnet upon this dust, he found it removed it from a sheet of paper as completely as if had been swept off with a brush, and he concluded that the non-metallic portions adhered to the iron particles by the thin layer of oil with which all the particles of dust were coated.

To prevent this dust passing into the atmosphere of cities, Mr. Stodder recommended a plan which had been put in practice many years ago in this country, but abandoned from the indifference of the workpeople, viz., the fixing of magnets in the immediate neighbourhood of grindstones and polishing wheels.

In the same report, Mr. Stodder alludes to the labours of two members of this Society—Dr. Angus Smith and Mr. J. B. Dancer—in examining the contents of the air, and points out an important matter considerably affecting the results of such investigations, viz., the method employed for filtering the air through water. The usual method has been to place a small quantity of pure water in a large bottle, and shake it in the air under investigations, repeating the operations with renewed volumes of air in the same water; but Mr. Stodder shows how impossible it is to intercept all the foreign particles in the atmosphere in this way, inasmuch as the smallest bubbles of air which pass through the water very much exceed in size the particles of matter which are sought for, and myriads must elude observation. A greater difficulty, however, is to obtain absolutely pure water for such experiments, and whether filtered or distilled water was used, a drop evaporated on a glass slide always left a deposit of scaly and granular particles. This result, as Mr. Stodder justly says, puts an end to this mode of investigation, and throws a cloud of suspicion on all reported researches in this line, when water was the medium used.

Mr. Bailey stated that the information communicated above had been extracted from an official document emanating from the State Board of Health of Massachusetts, and he commended it to the Officers of Health and to the Corporations of Manchester and Salford, as an illustration of what is required in this neighbourhood. The document just issued gives a summary of the work done during the past year, and embraces reports upon Public Abattoirs; the Cattle Plague, and its Effect on Milk; an Outbreak of Typhoid Fever; the Overcrowding of Tenements and want of Clean Streets in Boston; Smallpox; Poisoning by Lead; Trichiniasis in Massachusetts; Health of the various Towns in the State; Homes for the People; Alcoholic Drinks; Mortality of the City of Boston; Ventilation of School-houses; Water Supply, and its Comparative Purity; Air, and some of its Impurities; Health of Children employed in the manufacture of Textile Fabrics; Effect of Sewing Machines on Health, &c., and all this at a cost of under £600 the year.

ON THE ADULTERATION OF FOOD,

PRINCIPALLY WITH A VIEW TO ITS DETECTION BY THE MICROSCOPE.*

By WALTER MORRIS.

ADULTERATION was defined as being the fraudulent addition to any substance of another, for the sake of increased sale or profit. There are several modes of accomplishing this end; the first, and the most common, is by the addition of some article to increase the bulk or weight, as when starch is added to mustard, and cheaper flours to wheaten flour; the second by improving the appearance and apparent quality, so as to sell an inferior article at the price of a better, as in the case of the artificial colouring of pickles made of stale vegetables to resemble fresh. One of the commonest apologies for these practices is that the public prefer the adulterated article to the pure; that, for instance, pure mustard "will not sell." This allegation is, however, hardly a fair one, as the pure article is never offered; and, doubtless, if the pure article were used as freely as the ordinary mixture, it would be found unexpectedly pungent. But the fallacy of such apologies has been exposed by the example of pickles, which under this plea used to be invariably coloured with an artificial and frequently poisonous pigment. The public eye was thus educated to expect them of a bright green; yet, since some manufacturers have exposed the fraud and sent out pure pickles, the public have completely turned round, and avoid any which show an unnatural colour.

The adulteration of bread and flour with alum, to make them look whiter and of a superior quality, has to some extent diminished; but that substance is often replaced by the still worse sulphate of copper, or blue vitriol, which was recently detected in sixteen out of twenty loaves tested. In this case the public has been led to suppose that the quality of bread is shown by its whiteness, whereas by taking out the bran a most valuable part of the grain, viz., its azotised or flesh-forming portion, is lost. Less dangerous admixtures are those of cheaper flours, such as barley, rice, and "cones" (the latter made from a species of wheat called revet), and even beans.

The adulteration of coffee with chicory, though so well understood, exists, especially in poorer neighbourhoods, to an extent hardly credible. Out of forty-seven samples, eighteen were found pure, the lowest price of which was 1s. 4d. per lb.; of the rest, most were half, and some were wholly, composed of chicory, which, being worth about 6d. per lb., was thus sold at 1s. and 1s. 4d. The difference can be readily detected by the microscope, the cells of chicory being much larger, and the cell walls much thinner, than those of coffee.

* Abstract of a Paper read before the Manchester Literary and Philosophical Society.

Even chicory itself is much adulterated; out of fifty-seven samples only about one-half were pure, the adulterants being roasted wheat, acorns, beans, carrots, and sawdust.

Tea is less subject to adulteration than many articles of food; such abominations as the celebrated Maloo mixture, consisting of old used leaves re-dried, willow leaves and twigs, and even iron filings, have been quickly detected and refused by the trade. The "facing," however, of green tea with poisonous colouring matter is both absurd and harmful: and it will probably be continued so long as the public are content to accept such a palpable imposture as "genuine green."

It is a matter of opinion whether cocoa as ordinarily sold is to be considered an adulterated or a manufactured article. It is seldom sold pure and alone; being usually mixed with starch and sugar—the term "pure cocoa" is, therefore, in most cases, intended to mislead. Some kinds have lard or suet admixed, and to others red ochre is added to bring up the colour, rendered pale by an excessive quantity of starch. The relative quantities of these component parts in any sample of cocoa may be readily ascertained by the microscope; that of starch may be roughly seen by shaking up some of the cocoa with water in a test-tube or tall bottle, breaking up the lumps, and then allowing all to settle; when the starch will sink to the bottom and form a white layer beneath the cocoa. On warming the water, the fat will of course float on the top, and the sugar will be dissolved. The sugar crystals and fat are also shown by re-drying the solution on a glass slide.

Sugar is mixed with inferior kinds of the same article, but not (as popularly believed) with sand; the chief impurities in raw sugar are cane fibre, accidental dirt, and the sugar mite or acarus. The latter exists in most raw sugars (out of 72 samples 69 contained mites); but more abundantly in the moderately brown kinds than in the darker. The insect is barely visible to the naked eye. To obtain specimens, the sample should be dissolved in tepid water and well stirred, then allowed to stand a few minutes, and the acari will be found as minute particles floating on the top. The process of refining entirely removes these and the other impurities named.

Mustard is invariably adulterated with flour, which forms one-half or three-fourths of the article as usually sold. It may be readily detected by the microscope, mustard itself containing no starch whatever. Turmeric is often added to bring up the colour after this wholesale admixture, and cayenne to give it strength.

Pepper may now be obtained pure of respectable dealers; but as regards the cheaper kinds, and in poor neighbourhoods, it is largely adulterated with meal or starch, gypsum, and dirt of any kind, to give bulk and weight. The starchy substances may be detected by the microscope, the earthy ones will be left as ash after burning, and their character may be ascertained by the polariscope. The particles of pepper itself are easily recognised by the characteristic stellate cells in the outer skin, and the hard angular ones of the inner part of the seed.

Many examples of the above and other kinds of adulteration, mounted for the microscope, were exhibited at the same time, for comparison with pure specimens.

NOTE ON THE SPECTRUM OF THE CORONA.

By Professor C. A. YOUNG.

In an article upon the Solar Corona, which appeared in the *American Journal of Science*, May, 1871, I wrote, "Very perplexing also is the fact that the faint continuous spectrum, which must be in part produced by this polarised component of the corona's light, shows no discoverable traces of the dark lines of the ordinary sunlight spectrum. Probably they exist, but are in some way masked so tha they are not easily detected."

On further reflection, however, I believe the matter is readily explained, and that, on the other hand, it would have been remarkable if we had been able to bring out the Fraünhofer lines.

The truth is that the reflected photospheric sunlight forms only one small fraction of the total coronal radiance, the other constituents of which so far preponderate that it becomes very difficult to detect in the general spectrum the characteristics of this reflected light.

The spectrum of the corona is, in all probability, composed of at least *four* superposed elements.

1. A continuous spectrum, without lines either bright or dark, due to incandescent dust—that is, to particles of solid or liquid meteoric matter near the sun. For although I am not able to admit with Mr. Proctor that the whole explanation of the corona is involved in the presence of such meteoric particles, yet it cannot be doubted that they are very numerous; and any that may come within 250,000 miles of the solar surface must become incandescent and give such a spectrum as described.

2. A true gaseous spectrum of the second order, consisting, like all such spectra, of a more or less bright continuous background with well marked maxima or bright lines. In this case one bright line (1474) certainly exists, and perhaps several. So far as the spectroscopic evidence goes, this gas may be simply the vapour of the meteoric dust above alluded to, liberated by the heat of the sun, as when powdered sodium is dropped into an alcohol flame; or it may be disengaged for the instant from the same particles by electric discharges between them, as when the bright lines of metallic vapour appear in the spectrum of the spark produced by an induction coil. But in my previous article I have stated reasons for believing that the gas is of a more permanent character—a solar atmosphere through and in which the meteoric particles move as foreign bodies.

3. A true sunlight-spectrum (with its dark lines) formed by photospheric light reflected from the solar atmosphere and meteoric dust. To this reflected sunlight undoubtedly is due most of the polarisation, and were it possible to separate the polarised component of the coronal light from the rest, we might perhaps hope to find in it traces of the Fraünhofer lines. It is by no means impossible, however, that the spectroscopic character of reflected light may undergo some change, such as a partial obliteration or degradation of its lines, when the reflecting particles are sufficiently minute—small, that is as compared with the dimensions of a wave of light, so that they do not merely reflect the undulation at their surfaces, but themselves enter into motion bodily. Experiments upon the spectrum of the light emitted by one of the so-called actinic clouds, would, perhaps, clear up the subject.

4. Another component spectrum is due to the light reflected from the particles of our own atmosphere. This is a mixture of the three already named, with the addition of the chromosphere spectrum; for while at the middle of an eclipse the air is wholly shielded from photospheric sunlight, it is of course exposed to illumination from the prominences and upper portions of the chromosphere. This light from the terrestial atmosphere, like that reflected by particles near the sun, is evidently partially polarised in radial planes.

And if there is between us and the moon at the moment of eclipse any cloud of cosmical dust, the light reflected by this would come in as *fifth* element. It would, however, only differ from that reflected by our own atmosphere by including a greater or less modicum of photospheric sunlight.

Furthermore, in instruments like those employed by Messrs. Abbay and Pye, the chromosphere spectrum overlies that of the corona, and increases the complication.

It would seem, therefore, that only a small percentage

of the light which falls upon the slit of the spectroscope during a total eclipse contains the Fraünhofer lines at all, and it ought not to be considered strange that they are not readily observed.

In the same article I have stated that the photographs taken by the American party in Spain appear to differ essentially from those obtained by Mr. Brothers in Sicily.

This statement was based upon a comparison instituted by Mr. Lockyer, Professor Winlock, and myself, between a copy of the American photograph and a drawing* of Mr. Brothers's photograph, which (drawing) he had himself sent to Mr. Lockyer.

There was a general and even striking agreement between the two in respect to the position of the gaps and the distribution of the luminosity, yet there certainly were, as Mr. L. pointed out, very noticeable and important differences, and of a character to suggest that the extensive outside radiance might probably be of a less permanent character than the leucosphere, and of a different origin.

But I understand that when photographic copies of Mr. Brothers's and the American negatives are made to a common scale then these differences disappear, and the agreement becomes nearly absolute in respect to all essential particulars. If this be so, it certainly bears very strongly in favour of those theories which assign a purely solar origin to the whole phenomena.—*American Journal of Science.*

REPORT ON THE

MOLECULAR DISSOCIATION BY HEAT OF COMPOUNDS IN SOLUTION.

By CHARLES R. C. TICHBORNE, F.C.S., M.R.I.A., &c.

Part I.

Introduction.

M. Deville's researches upon the dissociation of compounds by heat when converted into the gaseous condition, have brought prominently before us the antagonistic nature of thermal to chemical force.† We find that the antagonistic action of these forces is manifested when we are dealing with compounds in the liquid condition, or in the so-called solutions of solid substances. It is a commonly acknowledged idea that in such cases heat hastens and modifies chemical decompositions, but how it modifies them, and to what extent, are questions which are seldom clearly defined.

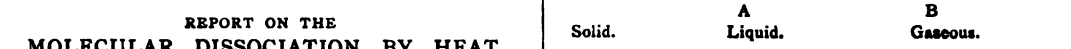
The main purport of this report is the application of such enquiries as those mentioned to the science of chemical geology. I may remark that some of the hypotheses mentioned in the course of my paper are generally acknowledged, some indirectly accepted, and some emanate from myself. Similar remarks will apply to the phenomena observed. To specify, or enter too fully into these niceties, would needlessly cumber my report with extraneous matter, and I have therefore determined to leave such points to the reader's discrimination, except in a few special cases.

We may have various phases of decomposition according to the force with which the molecular fragments of a compound are held together, and it is immaterial whether we consider such bodies as built up by the direct addition of molecules or by substitution. Compounds of a complex nature must be viewed as an aggregation of perfect entities, capable of having an individual existence, but these component molecules cannot be taken into account when we are considering the more complicated molecule, *e.g.*, morphia splits up on the application of heat into apomorphia and water. No one could for a moment suppose that the molecule H_2O existed as water in the morphia, as its removal radically changes all the properties of the resulting compound. The more complex molecule has peculiarities which are not common to its factors, and *vice versa.*

The importance of a study of such points in connection with chemical geology is almost self evident; but I may as well state that in this report the subject has been merely considered from a chemical point of view. The surface of the earth has been, and is, undergoing superficially a rapid change from its primitive condition of igneous construction. This change is continuously going on, and growing more and more profound. In this metamorphosis water may be considered as the prime mover towards the ultimate results of the chemical as well as the physical arrangement of our earth's surface. Such a line of study is as invaluable as it is difficult, and it will be my endeavour more to open up this line of research, than attempt to master even a moiety of such knowledge.

Compound molecules exist as solids, liquids, and gases, provided that the temperature necessary to convert them into these physical modifications is not above the temperature at which their components are dissociated. The application of heat to a molecule may be graphically, although perhaps rather fancifully, represented by Fig. 1.

Fig. 1.



Now we can easily conceive that a substance A may be of sufficient structural stability to pass through all the increasing vibratory action without dissociation of its component molecules, until it has passed through the solid liquid, and far into the vapourous condition, whilst a substance B has what I will call a thermanalytic point, or the point where the equilibrium upon such a line is broken. If it lies between A or B, we have dissociation in the liquid condition. A great number of compounds are dissociated above the point B (*e.g.*, anomalous vapour density of chloride of ammonium), whilst those dissociated between A and B are less common and are much less easy of observation.

Of course the following broad rules may be accepted. 1. The greater the temperature, the greater the number of molecules capable of dissociation, or the greater the tendency to dissociation. And on the contrary, the lower the temperature, the greater the molecular stability. 2. The more complicated the construction of the molecule, the lower the temperature at which dissociation commences; and after disruption, the higher the temperature necessary to carry on further dissociation of the residual molecule. 3. As a corollary, it follows that example of dissociation by heat in liquids, or of solids in solution, are comparatively uncommon, but that when such phenomena do occur, they materially affect ordinary reactions, and that, *cæteris paribus*, decompositions at one temperature will not of a necessity correspond with those effected at another temperature.

In aqueous solutions and at ordinary pressure all molecular dissociation must occur under 100° C., that is to say, within the boiling-point of the fluid in which the substance is dissolved. Under pressure, however, from the increased range of temperature, extraordinary phenomena may be induced, and thus heating in sealed tubes offers facilities for producing decompositions that cannot be brought about at ordinary temperatures.

Dissociation of compounds in solution, unless accompanied by some ocular demonstration, is apt to be overlooked, from the simple fact that the molecules rearrange themselves generally in the same form on cooling, and thus the change is transient. Frequently, however, both in mixtures and simple solutions, a dissociation is accom-

* I am not sure but we had a photographic copy of Mr. Brothers's drawing instead of the drawing itself; but we did not have a photographic copy of the original negative. No such copies had then been made.

† The modifications of force are for convenience considered in this paper as separate entities.

panied on cooling by a re-arrangement of the two or more groups of molecules according to the altered affinities. The statical condition having been once broken, a different arrangement may take place.

I may illustrate the phenomena to which I have referred in the introduction, by the consideration of a few of the most simple cases.

None are more common than dehydration. The molecules, H_2O, in such cases forming the crowning particles of complicated structures are held thereto with but a feeble force, and are easily dissevered even in solution. Lime-water is a familiar instance, and although it has not, that I am aware, been demonstrated, there can be little doubt that the precipitate got on boiling that fluid is due to dissociation of the molecule of water, or its dehydration, thus. The action of heat upon the hydrate of lime ($Ca''O$; H_2O) is to produce $Ca''O$ and H_2O, $Ca''O$ being insoluble in water, or very much less soluble than its hydrate. The first is probably what takes place. The insolubility is, however, concurrent with the rise in temperature.

As there do not seem to be any experiments extant except the original ones of Dalton, this subject was considered sufficiently important to verify, as they bear upon an investigation to be ultimately embodied in this report.*

Experiment 1.

A saturated solution of lime was formed in the following manner:—

Freshly burned lime was slaked and washed by decantation (distilled water being used), the residual lime was then digested with fresh water for twenty-four hours, with occasional shaking. This, on subsidence, constituted the lime-water used. It is hardly necessary to observe that all this manipulation was carried on in a stoppered bottle. The bright lime-water was poured off into a flask; this was brought quickly to the boil, and whilst boiling poured upon a filter arranged in the following manner:—

A glass funnel was placed inside a double funnel of tin, the outer space of this double funnel being filled with glycerine, which was kept as near the boiling-point as practicable (the boiling-point of "Price's Glycerine" is about 177° C. to 182°). By this means the lime-water is kept as near to the temperature of dissociation as possible during the whole of the draining and drying, which is only a matter of about half an hour. Hydrate of lime dried over sulphuric acid does not suffer loss on being submitted to a similar temperature. The precipitate was brushed into a platinum crucible and weighed; it was then ignited and the loss calculated.

In two determinations the weighings showed a considerable reduction, but in both cases this was much under the quantity required by a true hydrate.

Thus—

	Weight of precipitate.	Loss on ignition.	Percentage $Ca''H_2O_2$. Theory.	Practice.
1st determination ..	0·155 grms.	0·031	24·33	20·00
2nd ,, ..	0·131 ,,	0·023	24·33	17·56

It is curious to observe that the second determination gives the amount of loss required by the formation of a hydrate having the composition $3Ca'O$; $2H_2O$, viz., 17·64. This experiment was executed as rapidly as possible.

In the above determinations, the only point that was satisfactorily established, was the fact that a dehydration really does take place, and that the molecule H_2O is to a certain extent torn from its chemical position, even in the presence of an excess of water, and that it is not due to any specific insolubility of the hydrate at 100° C.

Experiments 2, 3, and 4, were to determine the solubility of lime at different temperatures. Chemically pure carbonate of calcium was prepared by dissolving the precipitated commercial preparation in hydrochloric acid, and by treating the resulting solution with sulphide of hydrogen and filtering. The filtrate was then allowed to digest with a slight quantity of ammonia, and again filtered after warming. A few drops of sulphuric acid were added, and it was allowed to stand twenty-four hours before filtering from the precipitated sulphates. From this solution the carbonate was prepared with the aid of carbonate of ammonium. The well-washed carbonate was ignited in a platinum crucible, until it no longer effervesced on the addition of dilute hydrochloric acid. Having procured what might be considered as pure lime, the next point was to determine its solubility at different temperatures in the following manner.

Expt. 2.—*Determination of the Solubility at* 15·5° C.

After standing upon an excess of lime for some days in a silver flask, a lime-water was procured by decantation. For twelve hours before pouring off it was rigorously maintained at a temperature of 15·5° C. 4000 grain measures were operated upon in each determination. In the two last determinations the lime-water was filtered in an apparatus by which as much as possible of the atmospheric carbonic anhydride was excluded. I am of opinion that these last determinations give the results as a little under the mark, but I am also of opinion that decantation probably gives it over; for these reasons the average of the three experiments have been taken. The estimation was made with a volumetric solution of sulphuric acid, 100 degrees of which would neutralise one equivalent of monovalent element.

	Degree of vol. solution.
1st determination (decanted)	20
2nd ,, (filtered)	19
3rd ,, ,, ...	18·9

Therefore, as $19·3.\frac{Ca''O}{200} = 5·405$ grains of lime present in 4005, so 1 grain of lime, or its equivalent of hydrate, requires 741 grains of water at 15·5° C.

Expt. 3.—*Determination of the Solubility of Lime at* 100° C.

A small copper boiler was used in this experiment which was provided with a valve to regulate the pressure, and a thermometer to indicate the temperature in the interior.

Through the top of this boiler passed what may be described as a kind of "Beal's filter." It consisted of a glass tube bent at right angles, one of the ends of this tube being moulded into a bell-shaped mouth, which mouth was tied over with a piece of Swedish filtering paper, and over this again a piece of muslin, which might be also placed upon the other side if great pressure were going to be used. By this arrangement, although the orifice presented a perfect filtering medium, it would stand a considerable amount of pressure. This end was submerged about half way into the boiler, which was filled with pure lime-water procured as in the previous experiment. The other end of the tube was provided with a glass stop-cock. The stop-cock was closed, and the lime-water rapidly brought to the boil. On allowing the valve to exert a slight pressure in the interior, and opening the stop-cock slightly, the lime-water slowly flowed out, the

* The following quotations are taken from most of the recent authorities, and are all evidently based upon the original experiments of Dalton, published in 1810 ("A New System of Chemical Philosophy," part 11, by John Dalton, Manchester.) Dalton gives lime-water, formed at 60° F., as containing one grain in 778 grms. of water, and at 212 F., one grain in 1270. Watts's "Dictionary of Chemistry," vol. i., p. 718, says,—"Hydrate of lime is more soluble in cold than in hot water; hence, water saturated with lime, in the cold deposits the *hydrate when boiled*." Miller says, in his "Elements," part 2, p. 418, fourth edition, "Lime is soluble in about 700 parts of cold water. . . . . If lime water saturated in the cold be raised to the boiling-point, half the lime is deposited." Wurtz in his "Dictionnaire de Chemie," quotes Dalton's experiments, and says, "La chaux est peu soluble dans l'eau et elle présente cette particularité qu'elle l'est plus à froid qu'à chaud," &c.

pressure in the interior being just sufficient to force the lime-water through the bibulous paper, and up the capillary tube. The thermometer would occasionally go up a degree, but this was at once remedied by opening the valve. When a sufficient quantity of water had been collected in this manner the amount of lime was estimated as in the previous experiment.

In two determinations 3002 grains consumed 8 degrees of the vol. solution $8.\frac{Ca''O}{200} = 2{\cdot}24$ grains lime present, or 1 in 1340.

Expt. 4.—*Determination of Solubility at* 109° C.

This experiment was performed in exactly a similar manner to the previous one, except that the valve was so placed that it blew off at a pressure corresponding to a temperature of 109° C. 3000 grains obtained in this manner consumed six degrees of the volumetric solution of acid, $6.\frac{CaO''}{200} = 1{\cdot}68$ grains of lime in solution.

These results may be tabulated as follows:—

One part of water at	Takes up of Ca"O.:
15·5° C.	$\frac{1}{741}$
100° C.	$\frac{1}{1340}$
109° C.	$\frac{1}{1785}$

and so on, until a point would be reached at which lime would practically be insoluble.*

The dissociation of water from lime seems peculiar to many of its compounds, and seems connected with the dimorphism of carbonate of calcium (see "Calcite and Arragonite.")

The determination of the solubility of lime at different temperatures are of importance in connection with this report, because, independently of its geological bearing, it affords a simple but illustrative example of the dissociation of compounds generally when in solution.

In this example we have the combined molecule H_2O becoming separated in the presence of an overwhelming excess of water from the dissociative influence of heat.

The gradual character of the action is also strikingly illustrated, the dissociation being in ratio to the increment of temperature, and is, under ordinary circumstances, only stopped by having arrived at the maximum temperature of water at the pressure of the atmosphere.

The phenomenon, however, is capable of further extension under increased pressure *ad infinitum*. The laws of molecular dissociation by heat have been only studied as far as regards volatile substances, but these laws seem applicable to the solution of substances modified by the altered physical condition, and are in their phenomena very similar. Thus, in speaking of gaseous dissociation in connection with the laws of Avogadro and Ampère, M. Wurtz makes the following remarks:†—

"Un des meilleurs arguments qu'on puisse invoquer en faveur de cette interpretation est celui qui est tiré de la densité du vapeur du bromhydrate d'amylène. C'est une combinaison liquide du carbure d'hydrogène d'amylène avec l'acide bromhydrique. Portée à une température peu supèrieure à son point d'ebullition cette combinaison montre une densité de vapeur qu'on peut appeller normale, parce qu'elle repond à 2 volumes de vapeur pour 1 molecule. La vapeur est intacte à cette temperature, mais dès qu'on la chauffe, elle va éprouver une décomposition plus ou moins complète, suivant que la chaleur fournie aura été plus ou moins considérable. . . . . Mais cette décomposition est graduelle; elle ne s'achève pas à un degré fixe, mais entre des limites de température assez étendues, de telle sorte que la vapeur, intacte à un certain degré, se trouve melangée, à des degrés plus élevés, avec des portions de plus en plus notable de ses produits de décomposition, jusqu'à ce qu'enfin la temperature s'étant élevée encore, la decomposition se trouve achevée. A ce moment, la densité de vapeur est descendue á la moitié de ce qu'elle était d'abord. Peut on en conclure que le bromhydrate d'amylène offre deux densités de vapeur? Il est évident qu'il ne saurait en être ainsi, et il est naturel de penser que la vraie densité de vapeur est celle qui a été déterminée à une temperature assez basse pour qu'on soit en droit de supposer que la molécule est encore intacte. Que si cette densité décroit avec la température, cette circonstance est due a l'action de décomposition que la chaleur exerce sur la vapeur."

Again, in speaking of the exceptions to the laws of Avogadro and Ampère, he says—"Deux molecules, capables de prendre chacune la forme gazeuse, sont remises par l'affinité en une molécule plus complexe. Il peut se faire que le point d'ébullition de celle ci soit situé assez bas pour que la chaleur qu'elles avaient perdue en s'unissant; elles demeurent alors en combinaison. Mais peut on s'attendre à ce qu'il en soit toujours ainsi? E l' affinité de deux corps l'un pour l'autre ne peut elle pas être assez faible, ou le composè qu'ils forment assez peu volatil pour que le point de décomposition soit situé au dessous du point d'ebullition?"

Substances in solution must behave in a similar manner to those in a gaseous condition, except that in such cases it is only the more loosely combined molecules that are effected at ordinary pressure, but still we cannot conceive that there could be any limit to this decomposition under extraordinary pressure such as would be exerted frequently, subterraneously.

We know that compound structures are capable of being separated piecemeal—*e.g.*, a compound of alum. The molecules are removable, commencing with the water of crystallisation, and ending with its most ultimate molecules. Thus, let us take the trimethylamine alum† a well defined compound, exactly similar in general construction to ordinary alums ($C_3H_{10}N,Al'''$; $2SO_4.12H_2O$). We see at once the great number of molecular points of dissociation it is capable of being divided into, beginning with the first 10 molecules of H_2O that, according to Gerhardt, are removable at 120° C. or ending with—

$$\left.\begin{matrix}CH_3\\CH_3\\CH_3\end{matrix}\right\}N.$$

Hertwig says the molecules H_2O are removable in three instalments. How far the action of heat is capable of splitting up this structure when in solution resolves itself into a question of pressure, but it will be seen further on that on the application of heat to such a compound as an alum, it reacts upon all the more unstable parts exactly as if they were not grouped together in the first instance, and that the whole structure is, if anything, lowered as regards its thermanalytic point, and thus weakened by its complexity. As the components are removed the residue has more stability.

The molecules known under the terms "water of crystallisation" are but slightly removed from the water of "hydration," and but slightly removed from the water of

* Dalton's experiments upon this subject are in his "New System of Chemical Philosophy," Part 2; Manchester, 1810. They are as follows:—When water of 60° is duly agitated with hydrate of lime, it clears slowly, but a quantity of lime-water may soon be passed through a filter of blotting-paper, when it becomes clear and fit for use. I found 7000 grains of this water required 75 grains of test sulphuric acid for its saturation, consequently it contained 9 grains of lime. If a quantity of this saturated water, mixed with hydrate of lime, be warmed to 130° and then agitated, it soon becomes clear; 7000 grains of this water decanted require only 60 grains of test sulphuric acid. The same lime-water was boiled with hydrate of lime for two or three minutes and set aside to cool without agitation; it very soon cleared. 7000 grains being decanted require only 46 grains of test sulphuric acid to be neutralised, the test acid being as usual 1·134. Hence we deduce the following table:—

One part of water at	Takes up of lime:	Hydrate of lime:
60° F.	1·778	1·584
130° F.	1·972	1·729
212° F.	1·1270	1·252

† "Histoire des Doctrines Chimique," par Ad. Wurtz, p. 79.

† There being no practical line of demarcation between what is known as "organic substances" and "inorganic substances" as regards the laws of dissociation, examples taken from organic chemistry are *en rapport* with the objects of the paper.

solution; frequently the alteration of a few degrees of temperature are sufficient to convert one into the other, *e. g.*, sulphate of sodium and salts that dissolve in their own water of crystallisation.

The water in the salt seems to be in a crystalloidal condition, but as a colloid in the other case. The crystalloidal water, even in solution, frequently is capable of dissociation, and of apparently changing its condition. Such changes produce the phenomena of supersaturated solutions.

The phenomenon of solution is a demonstration of force and of actual combination between the molecules of water and the substance dissolved. But if the more intimate unions be taken, it is evident that in such cases as hydration or water of crystallisation the molecules that we recognise as H_2O are playing different formations, or are in a different condition to the water of solution.

In an octahedron crystal of ammonia-alum water is almost essentially the geometrical solid, and is as important as the alumina, ammonia, or other elements.

If this alum be dissolved by applying heat, it is split up into a substance which is no longer alum geometrically or chemically, although we have got conventionally into the habit of saying it has "dissolved in water," or it has "dissolved in its water of crystallisation," as the case may be. It is not only decomposed, but requires some little time for the molecules of water to regain their accustomed position or crystalloidal condition—so that they may be assimilated into the edifice—as illustrated by the following.

Experiment 5.

A saturated solution of the ammonia ferric alum was poured upon a small quantity of the crystals of the same salt, and a few drops of acid added to prevent the precipitation of a basic salt. It was quickly brought to the boil, and then allowed to remain at rest until it had regained the original temperature, 15° C. Although the solution had a thermometer frequently inserted and withdrawn, there was no indication of crystallisation until some three to four hours had elapsed. Now, under the ordinary rules of solubility these crystals should begin to form immediately that the thermometer reached 15° C. This phenomenon is exhibited by all the hydrated soluble salts in some degree; it is particularly the case with the alums.

A very interesting and remarkable group of molecules are the basylous trioxides—of which, however, we need only consider three. These three bases are $Al_2'''O_3$, $Cr_2'''O_3$, and $Fe_2'''O_3$, oxides which perform a very important part in our earth's crust, and possess well-known properties in common, The first and last alumina and ferric oxide are, perhaps, the most important of the mineral world, if we except silicon and lime. There is a wonderful analogy between all their compounds, and they all possess in common a less degree of molecular stability from complexity of construction, and *ergo* a corresponding susceptibility to the action of heat when in solution.

M. Debray has lately published some ingenious observations upon the action of heat upon one of these solutions, namely, the ferric salts.* As my own experiments, however, have led to rather different results, I have simply given my own experience, and feel less delicacy in doing so from the fact that my investigations in this direction were well known, and have a prior date to those of M. Debray. I exhibited some experiments upon the dissociating influence of heat on these solutions before the Dublin Chemical Club in 1867.†

This dissociation is well marked in the ferric salts by the colour of their solutions. All the ferric salts are nearly colourless, or possess a very faint lemon tinge. It is probable that if we could get the tri-salt in solution without decomposition, a perfectly colourless liquid would be the result.

* *Comptes Rendus*, April, 1869.
† *Minutes of the Dublin Chemical and Philosophical Club*, 1867.

Experiment 6.

Ferric chloride, obtained by passing chlorine over iron filings heated in a porcelain tube, was dissolved in a moderate quantity of pure water (free from ammonia). A dilute solution of hydrochloric acid was then added, drop by drop, until the minimum point of colouration had been obtained. The iron was then estimated by precipitation with ammonia, and the chlorine by nitrate of silver.

The following figures represent the results obtained:—

	Practice.	Theory, per cent.
Fe	33·91	34·46
Cl	66·09	65·54

This slight increase in the amount of chlorine is evidently due to the basylous action of the water, and chromatic neutrality of such salts is dependent upon the amount of dilution, and is, in a certain sense, independent of the chemical neutrality. A chemically pure salt when dissolved gives a slightly basic solution, depending upon the relative volume of the water it is dissolved in.

Experiment 7.

The further addition of acid produced a darkening of the solution which had previously been rendered as neutral as practicable. Therefore, both acidity and basicity produce colours in these solutions.

Heat applied to these solutions gives an intense darkening in ratio to the temperature employed. It is almost certain, as will be seen from the experiments detailed, that the first action of the heat is the dissociation of crystalloidal water, and then the splitting up of the structure into a basic salt and free hydrochloric acid; and that the dissociation may be carried ultimately so far as results in the total splitting up of the structure. These results do not, however, agree with M. Debray's conclusions. Presuming that there is no other disturbing cause, the molecules regain their original arrangement of structure on cooling; but time becomes an important element here, the time required being in ratio to the extent of dissociation. The preparation of the ferric salts used was effected in the following manner:—

A neutral persulphate was formed in the moist way, preference being given to this method to that first adopted, namely, that of making the chloride obtained by sublimation the starting-point.

To a weighed quantity of ferrous sulphate dissolved in water the requisite proportions of nitric and sulphuric acids were added by the aid of volumetric solutions, carefully adjusted. The salt was evaporated to dryness at about 80° C., and after powdering was kept for some days at a temperature of about 75° C. This powder when thrown into water slowly dissolved in the cold, giving a slightly tinged and basic solution, which required the cautious addition of weak sulphuric acid. The addition of chloride of barium to this salt in equivalent proportions gave also a neutral solution of ferric chloride, &c.

Experiment 8.

A concentrated solution of ferric sulphate was submitted to a temperature of 100° C., the solution gradually became darker during the increment of heat. But there was no evidence of precipitation.

Experiment 9.

The above solution was rather copiously diluted, and on being re-heated it gave a basic precipitate of a yellow character, which contained sulphuric acid. Placed under the microscope it was seen to consist of semi-transparent and crystalline masses. By long and continued boiling a precipitate was procured in a more concentrated solution.

Experiment 10.

The basic precipitate procured in the above experiment was sealed up in a tube with the liquid in which it was formed, and occasionally agitated. After the lapse of some

considerable time it re-dissolved, with the formation of the original salt. To ensure success it is necessary that the boiling in the first instance should not be carried too far, and that the fluid be not too much diluted. A similar tube tied upon the beam of a steam-engine to ensure constant and energetic agitation gave the same results in two days.

(To be continued).

CORRESPONDENCE.

VITALITY OF DISEASE GERMS.

To the Editor of the Chemical News.

Sir,—Allow me, in reply to a letter which has appeared in the Chemical News of the 20th inst., signed H. B. Yardley, to state that if that gentleman will kindly refer to my paper on the "Action of Heat on Germ Life Dried on Cotton Fabrics," which appeared in the Chemical News of September 22, he will find at page 138 an answer to the question he asks.

If there is still vibrio life at 300°, and the calico is rendered tender at that temperature, I cannot see what further light would be thrown on the subject by repeating the experiment at 330° as suggested by him.

Permit me to trespass further on your space by alluding to a serious omission which occurred in the printing of my paper on the "Estimation of Sulphur in Coal and Coke," published in your issue of 18th August last. The sentence as printed reads—"The finely pulverised coal or coke is boiled for about twenty hours with water containing an equal weight of coal or coke taken. It should have been—"The finely pulverised coal or coke is boiled for about twenty hours with water containing an equal weight of carbonate of soda with that of the coal or coke taken.—I am, &c.,

F. Crace Calvert.

Royal Institution, Manchester,
Oct. 24, 1871.

VITALITY OF DISEASE GERMS.

To the Editor of the Chemical News.

Sir,—The recent experiments of Dr. F. Crace Calvert "On the Action of Heat on Protoplasmic Life" published in this journal have confirmed my suspicions, that an ordinary amount of heat is not sufficient to destroy the virus of contagion, but I will make this proviso, *in the absence of disinfecting agents.*

I have devoted a considerable portion of time to the study of disinfectants—in fact, sanitary chemistry generally, and the fact struck me as soon as I entered the field that the miasm was not destroyed by the heat of most disinfecting chambers. In fact, in some, where the heat employed is very low, owing to a badly constructed oven, very little good can accrue from the baking process alone. At the Sanatorium attached to Eton College the beds from the scarlatina patients used to be baked at rather a high temperature, but owing to scorchings having taken place the temperature has been considerably reduced. The heat now employed, if used alone, is, in my opinion, only just enough to warm the disease germ and make it feel very comfortable. The heat cannot be raised too high owing to its irregular working, the temperature being sometimes 40 or 50 degrees higher than the thermometer indicates. In December, 1870, I found the heat was only got up to 120° F., but it was supposed to rise to 160° F. I gave as my opinion that the heat had very little action upon the disease germ, and proposed placing a vessel containing carbolic acid mixed with an equal volume of water in the hot chamber. I have now, since the appearance of Mr. R. Weaver's letter (Chemical News, vol. xxiv., p. 166), written to know whether the system proposed by me has been fully carried out. I find that for the last nine months, when articles have been placed in the disinfecting chamber, the heat has been averaging from 120° F. to 160° F., and a vessel of dilute carbolic acid (1 to 1) has been placed in the next compartment to the clothes. The vapour of the phenol has been carried over by the combined effects of heat and steam, and has saturated the clothing. This I consider a good method, certainly better than baking alone, for insuring complete destruction of any lower organism.

Previous to December, 1870, the method of disinfecting the patients' linen before washing, was to steep in solution of bleaching-powder, but owing to the solution being sometimes made improperly, holes were *burnt* in the clothing: I thereupon proposed a dilute solution of carbolic acid; it is easy to mix, perfectly soluble, and has no action upon fabrics in the diluted state.

I have just penned these few remarks as I hold the subject as one of the highest importance, and hoping it will raise a discussion in order to bring forth fresh facts.—I am, &c.,

George E. Davis.

Laboratory, R. Bealey and Co., Radcliffe.
October 16, 1871.

THE BESSEMER PROCESS.

To the Editor of the Chemical News.

Sir,—I have read with much interest the many excellent articles on the Bessemer process, which have of late appeared in the Chemical News. They convey much valuable information, but I cannot help thinking the well-known fact that the grey iron used for the Bessemer process is converted into white during the first period of the blow should have been noticed, more especially as the *full* carbon spectrum (from all I can gather) is not seen until this change has been effected.

Mr. Snelus's own analyses, also those of others, show that the graphite (in the grey iron) is gradually occluded or dissolved in the iron, and that the boil does not fairly commence until the change is complete. It is well-known the same change occurs in the refinery and puddling furnaces. In the latter I have noticed the boil does not commence until this point has been attained.

In many instances grey iron is passed through the refinery for this object alone, thereby greatly facilitating and shortening its subsequent puddling.

Further, I think it doubtful that graphite (as such) is burnt at all in the converter; it may be that it is unaffected by the blast, and is only oxidised after entering into combination with the iron.

I have one question to ask, to which I should like a reply from some of your correspondents whose chemical knowledge must, of necessity, be superior to mine. During the conversion of grey pig-iron into white as above, is there a decrease or increase of temperature in the fluid blown iron due to this cause alone? I have thought it probable the latter may occur.—I am, &c.

John Parry.

Ebbw Vale Iron Works, Monmouthshire.

THE AMMONIA PROCESS OF WATER ANALYSIS.

To the Editor of the Chemical News.

My attention has been called to a letter from Mr. Edward Nicholson, Assistant Surgeon R.A., Analyst of Waters Mysore and Ceder Districts, dated 18th August, 1871, and written in Bangalore. It was published in the Chemical News of the 13th inst.

In this letter Mr. Nicholson confirms my statement, that our ammonia process had been adopted by the sanitary officers of the Indian Government. He, however, gives his opinion that it was adopted rather too hastily, and says that in his own hands it has been a complete failure. I have to thank him for not resting satisfied with a summary comdemnation of our process, and for recording

the reasons why he condemns it. Among these reasons I observe that, in his hands, water to which quinine had been added failed to yield ammonia when subjected to our process. In answer, I beg leave to refer to some experiments published by Chapman and myself in the *Journal of the Chemical Society*, in the year 1868 (ser. 2, vol. vi., p. 165). From 100 parts of sulphate of quinine we obtained 4·5 parts of ammonia. Frankland and Armstrong have likewise published a determination of the amount of ammonia given by sulphate of quinine when it is submitted to the ammonia process, and even they so far agree with us as to exhibit a considerable yield of ammonia, viz., 3·64 per cent.

If any of your readers should be disposed to distrust the ammonia process on account of Mr. Nicholson's assertions respecting the working of it, I would recommend them to experiment on quinine before doing so.

Inasmuch as Mr. Nicholson failed to get ammonia from quinine, I am not surprised at his failing, in a general way, to obtain albumenoid ammonia from the waters of India, but I should hesitate to regard his failure to get ammonia as any reason for believing that it is not to be got when the ammonia process is efficiently worked.—I am, &c.,

J. ALFRED WANKLYN.

ELEMENTS, COMPOUNDS, AND MIXTURES.

To the Editor of the Chemical News.

SIR,—It is the general teaching of works on chemistry that matter is divisible into *two* classes, *elements* and *compounds*. Is this teaching true? I incline to the opinion that it is not, one reason for which I will proceed to state. Let us admit, for the sake of argument, that the teaching is true, and then proceed to the examination of one of the most common substances—atmospheric air. Before commencing to experiment upon the atmosphere, we can at once say it is either an element or a compound. On making our examination, however, we find that it is not the former, for it consists of two elements—oxygen and nitrogen, and two compounds—water vapour, and carbonic anhydride; neither is it the latter, for these elements and compounds are not held together by chemical attraction, which is characteristic of a compound. Now, since it belongs to neither of these classes, we must conclude that there are *three* classes of substances—elements, compounds, and *mixtures*—and that of this third class the atmosphere is a typical member.

I shall be glad to see the matter discussed in the columns of the CHEMICAL NEWS, so that the indefiniteness which at present prevails in the teaching on this point—to my mind at least—may be cleared up.—I am, &c.,

W. H. WOOD.

Halifax, Oct. 24, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, October 2, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Variable Aspect of the Protuberances and other Remarkable Portions Visible on the Sun's Surface; Classification of the Phenomena.—Rev. A. Secchi, S.J.—This very elaborate memoir is illustrated by a series of engravings.

Researches on the Reciprocal Conversion of the Allotropic States of Phosphorus.—(Second part.)—G. Lemoine.—It is not possible, owing to the great length of this memoir and to the fact that it contains a great many tabulated forms exhibiting results of experiments, to enter into details on the subject. The main results of the author's researches, while to some extent confirming the results of a very limited number of experiments made on this subject in 1865 by Dr. Hittorf (*Pogg. Ann.*, vol. cxxvi.), prove that the conversion of phosphorus is chiefly a phenomenon of tension of vapours.

Estimation of the Velocity of Light.—A. Cornu.

Spectra of Tin and its Compounds.—G. Salet.—The exhaustive description of the spectrum phenomena observed when tin compounds are volatilised in the flame of hydrogen. It appears that tin in this respect is a most curious substance, since its compounds yield each three different spectra, two of which belong to all, while the third spectrum is continuous.

Continuation of the Thermo-Chemical Researches on the Ammoniacal Salts.—Dr. Berthelot.

Composition of the Clays Belonging to the Coal Formation.—C. Mène.—In tabulated form the author exhibits the results of the analysis of thirty-seven different kinds of this clay as obtained in France, Belgium, England, and Germany. The determinations made are:—Water, lime, silica, alumina, oxides of iron, alkalies, carbonaceous matter, and sp. gr. The contents of this paper are valuable, but do not admit of reproduction.

Loss of Valuable Libraries.—From a short note we learn that the Préfet de la Seine and the Préfet de Police request the Academy to have the kindness to send any books it might be able to dispose of to the two authorities just named, the former asking for the once magnificent municipal library of Paris, and the latter for the once very good library of the Prefecture, both of which have been destroyed by fire during the late war.

Annalen der Chemie und Pharmacie, September, 1871.

The following original memoirs and papers are contained in this number:—

Studies on the Combinations of the Camphor Group.—J. Kachler.—The first instalment of an exhaustive essay on this subject, containing the following sections:—Oxidation of camphor; nitrocamphoric acid; acids obtained from the mother-liquor; bibasic salts; tribasic salts; oxicamphoronic acid.

Protein Compounds.—(First portion of essay.)—H. Hlasiwetz and J. Habermann.—This paper contains an exhaustive general introduction to this subject, setting forth a comparison between the carbohydrates and the protein compounds, as regards the products yielded by the action of various reagents and decomposition-inducing processes, such as, for instance, fermentation, nitric acid, action of nascent oxygen, sulphuric acid, fusing caustic potassa, and dry distillation. Next follows the detailed account of a series of experiments made with the view to ascertain with certainty the derivatives or decomposition-products of carbohydrates among the products of the decomposition of the proteine compounds.

Allantoine and its Derivatives.—Dr. E. Mulder.—This very exhaustive and lengthy memoir is divided into the following sections:—Preparation of allantoine according to Liebig's and Wöhler's method; nitrate of allantoine, $C_8H_8N_4O_3,NO_3H$; allanic acid, $C_8H_8N_4O_5$; allantusic acid, $C_7H_{10}N_4O_6$; allantoinic acid, $C_4H_6N_4O_4$; lantanuric acid, $C_8H_4N_4O_8$.

Conversion of Formic Acid into Methaldehyde.—Dr. E. Mulder.—After very briefly referring to his former researches on this subject, the author states that he has obtained a sulphur compound, CH_2S, which, however, was obtained in too small quantity to admit of further experimenting with it.

New Series of Aromatic Hydrocarbons.—Th. Zincke.—The contents of this paper are not suited for useful abstraction.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 7, 1871.

This number does not contain any papers relating to chemistry or collateral sciences.

Journal de Pharmacie et de Chimie, August, 1871.

This number contains the following original papers and essays:—

Researches on the Intimate Action of the Substances which Aid the Decomposition of Chlorate of Potassa while Employed for the Preparation of Oxygen.—Dr. E. Baudrimont.—This memoir is divided into the following chapters:—Action of heat on chlorate of potassa; decomposition of this salt under the influence of substances which do not act chemically upon it; study of the action which certain substances exert upon that compound; discussion of several theoretical matters relating to this subject.

Crystallised Aconitine.—Dr. Duquesnel.—A strictly pharmaceutical paper.

Peculiar and Extraordinary Alteration of the Bread intended for the Army.—Dr. Poggiale.—The contents of this paper bear upon the appearance in some of the bread alluded to of an *oidium*, a cryptogamic vegetable the spontaneous origin of which in the bread is not quite satisfactorily accounted for, but appears to have been more than once, although at long intervals, observed in the extensive

military bakery at Paris. The development of the *oïdium* (*aurantiacum*) alluded to renders the bread unfit for use, and in some degree even poisonous.

Note on the Existence of Copper in certain Waters.—Dr. Roux.—This paper contains the results of some experiments, chiefly made at the request of the Maire of Saint-Jean-d'Angely (Charente Inférieure), bearing upon the question that some of the spring-water of that town had become impregnated with copper, owing to the waste water of a coppersmith's shop having found, by percolation through the soil, its way to the spring. The result of very minutely conducted assays of the soil, as well as of the water in the neighbourhood of the works, revealed the presence of copper, but only in very small quantity. Water from Rochefort, pumped up by the aid of copper pumps, contained rather more copper; but in neither case was the quantity of that metal found in the waters alluded to so large as to be capable of giving rise to any injury to health, the less so as the French, by daily using copper cooking-vessels, obtain from these a sufficient quantity of copper in their system to render the detection of that metal in their blood an easy matter.

La France Scientifique (*Ancien Cosmos*), October 1, 1871.

This number does not contain any papers relating directly to chemistry or collateral sciences, but we call attention to the title of the first part of an essay:—

The Three Ages of the Globe; Introduction to a Critical Study on Darwinism.—Dr. V. Meunier.

Moniteur Scientifique, Nos. 333 and 354 (double number), September 1 and 15, 1871.

This number opens with a valuable essay:—

Extracts of Meat Considered in a Physiological Point of View.—Dr. P. Müller.—We quote the headings of the different chapters:—On muscular liquid; on beef-tea and meat extracts; on the organic principles present in these substances; action of potassa salts. The following conclusions are drawn by the author from his researches, corroborated by those of a great many others, among these Liebig and Virchow:—Meat extracts are neither directly nor indirectly food, for they do not contain albuminoid matter, neither do the nitrogenous principles which they contain arrest dis-assimilation, that is, they do not prevent the waste of the organic matter which composes the body. In small doses, these extracts are useful by the stimulant action of the potassa salts, which promote digestion and circulation; in strong doses—too large quantity at once—these substances may have a very injurious effect. When given to convalescents from serious diseases, especially if the system is exhausted by prolonged abstinence, the potassa salts present in these extracts in large quantity will act more injuriously because the system has lost a great deal of chloride of sodium; instead of then promoting the nutrition these substances will interfere with it—(1) by the direct action of the potassa salts on the blood globules, whereby the absorption of oxygen of these globules is greatly decreased; (2) by the predominance of such salts in the serum of the blood which only physically disselve carbonic acid and do not allow the normal quantity of that gas to be exhaled, and thus impede the access of oxygen. Medical men should bear in mind that if given alone these extracts, and the same applies to beef-tea, are no nutriment, and only tend to keep the convalescents weak and not only ill fed but not at all fed.

The following original papers relate to chemistry and collateral subjects:—

The First Idea of a Dial Telegraph.—Dr. Quesneville.—The author quotes a few curious lines taken from a work—"Récréation Mathématicque Composée de Plusieurs Problèmes Plaisantes et Facétieux," edited by Jean Leurechon, e S.J., Anno 1624, at Pont-à Mousson—the main gist of which is that the *savant* just named, while speaking of the magnet (loadstone), suggests that if a person, A, had a powerful stone at Paris, and was provided with a dial plate upon which the figures of the alphabet were engraved and to which a movable magnetised needle was adapted, and a person, B, being at Rome, was provided with a similar apparatus, these parties might, by previously agreeing to enter into conversation with each other at a certain hour of the day, so arrange as to be able by the aid of a strong magnet to converse with each other; it appears that there was added to the original text an engraving representing the dial and needles alluded to. The work just spoken of has been re-published in 1626 and in 1629 (printed at Rouen by Ch. Osmont). The passage alluded to also occurs in a work edited in 1636 by Wijnant van Westen, a mathematician at Nymegen (Netherlands) under the title "Mathematische Vermaeckelijkheden;" this work is an improved Dutch translation of the work of Leurechon, who used to write under the pseudonym of H. van Etten.

On Leukaniline.—O. Follenius.—The body just named, $C_{20}H_{21}N_3$, is the product of the reduction of rosaniline, and best obtained in pure state by boiling a solution of fuchsine with pulverised zinc until the liquid has become colourless; from the filtrate, leukaniline in crystalline state separates on cooling; but in order to obtain this substance quite free from rosaniline the residue on the filter should be digested with alcohol, and this solution, after filtration, treated with from four or five times its bulk of distilled water, whereby the leukaniline is precipitated. After having been collected on a filter, washed with cold water, and dried, the body is obtained in a pure state. Oxalate and acetate of leukaniline are briefly described; the first named of these salts becomes after a while red-coloured.

Researches on the Artificial Alizarine of Gessert Brothers, Eberfeld (Rhenish-Prussia).—F. Reverdin.—The substance alluded to is met with in commerce in the shape of a thickish yellow-coloured liquid, which was found to contain 10 per cent of colouring matter, consisting partly of alizarine, and partly of a pale orange-coloured crystalline substance, of which too small quantity was obtained to admit of its being analysed, but the author could ascertain that it was not anthraquinone; purpurine was not found in the material. The results of the dye-tests made with the commercial product and the substances obtained therefrom by chemical analysis proved that in every case this artificially-produced material is of first rate quality.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, October 5, 1871.

This number contains the following original papers:—

Comparative Experiments Made with Dynamite and Ordinary Blasting-Powder in Working Quarries and Mines.—F. Hamel.—The first instalment of a paper on this subject. This portion contains a review of the history of discovery, properties, and application of nitro-glycerine and of dynamite.

Description of a Magneto-Electric Machine which Produces a Constant Current.—M. Gramme.—Illustrated by woodcuts. The machine is made and sold by M. Bréquet, 39, Quai de l'Horloge, Paris.

October 12, 1871.

This number contains the following original papers:—

Comparative Experiments Made with Dynamite and Blasting-Powder.—F. Hamel.—Continuation of the treatise on this subject, belonging more to mining and quarrying than to chemistry.

Studies on the Dissociation of Chemical Bodies.—C. Mène.—The continuation of an essay on this subject.

Continuation of the Tabulated Review of the Composition of Fertilising Substances which may be added to Manures, or are fit for use as such by themselves.—C. Mène.

Les Mondes, October 5, 1871.

The greatest part of this number is devoted to an elaborate and valuable paper:—

Geology of the Alps and the Alpine Tunnel.—Professor Sismonda and Dr. Elie de Beaumont.—Illustrated by a lithographic plate.

Quantity of Wood Required for Working a Beet-Root Sugar Manufactory.—M. Simirenko.—The contents of this paper relate especially to Russia.

October 12, 1871.

The only original matter contained in this number relates to some recently-published scientific books of which we quote the following:—

La Chimie Nouvelle ou le Crassier de la Nomenclature Chimique de Lavoisier Déblayé.—C. E. Julien.—This work is written by a well-known engineer, and according to what is stated in the above-named periodical is a production which contains a great deal of valuable matter especially in reference to iron and steel.

Recherches sur les Meilleures Conditions de Construction des Electro-Aimants.—T. du Moncel.

Le Moniteur des Produits Chimiques pour l'Industrie, les Sciences et les Arts et du Matériel de ces Industrie Publié par une Société de Chimistes et d'Industriels, October 10, 1871.

In addition to some very elaborate and important papers bearing on political economy, this number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Chemical Products of Italy.—E. Rousset.—This paper, a continuation of former papers on this subject, contains the following sections:—Tallow candles; stearine candles; glue-boiling.

The Lucifer-Match Industry at Marseilles.—P. Bosc.—As an instance of the importance of this industry we quote the following:—One firm employs 600 hands, and consumes annually for the production of matches:—2·5 tons of phosphorus; 7 tons of chlorate of potassa; 1·5 tons of colouring matter; 8 tons of red lead; 16 tons of refined sulphur; 50 tons of stearine; 25 tons of spun cotton wicks; more than 50 tons of Japan wax; and 100 tons of wood. There is annexed to this factory a chromolithographic printing establishment capable of printing two, three, or six colours, and consuming annually 2000 reams of paper at 500 sheets to the ream.

Engraving on Glass.—A. Ae. Wilbaux.—By the use of types made of an elastic material the author prints on glass fluoride of calcium incorporated in printing ink; the glass thus printed on is next treated at a suitable temperature with sulphuric acid, and after having been washed with water contains in indelible engraving the figures of the types.

Chlorine Preparation.—Tessié du Motay.—The author first prepares chloride of manganese, and heats this in earthenware retorts, admitting at the same time steam and a sufficient quantity of either air or oxygen, but in that case there is also formed hydrochloric acid; if, however, air, or preferably oxygen only, are passed over the red-hot chloride of manganese, chlorine is given off and peroxide of manganese

reproduced. If over this material, heated to redness, a mixture of hydrochloric acid gas and air or oxygen is passed, chlorine is continuously produced and peroxide of manganese regenerated.

Gazzetta Chimica Italiana, 1871.

We have received the first volume (Nos. 1 to 7 inclusive) for this year of this newly-commenced publication, which augurs well for that country which was the land whence science and art spread over Europe, and which now exhibits in every part of its territory a revival of scientific applications and the development of the manifold natural resources. The original papers and memoirs met with in the earlier numbers of this work (a monthly periodical) have been almost simultaneously published in either German or French scientific periodicals, and have been quoted in our columns; but of the original papers, subsequently published, we shall give short abstracts.

Journal für Gasbeleuchtung und Wasserversorgung, Nos. 18, 1871.

The contents of this number bear strictly on matters relating to gas- and water-works' engineering and management.

Bulletin de l'Academie Impériale des Sciences de St. Petersbourg, Vol. xvi., No. 2, 1871.

This number contains the following original paper relating to chemistry:—

Action of Zinc upon Quadri-Chloro-Benzyl and upon some other Bromated and Chlorated Compounds.—N. Zinine.—The compounds of chlorine and bromine with the hydrocarbons formed by the direct addition of the haloids to the hydrocarbon are violently acted upon by the zinc, the result being the reproduction of the hydrocarbons they are derived from, but the haloid compounds of the hydrocarbons formed by substitution are not thus acted upon by zinc. Quadri-chloro-benzyl, the elementary composition of which corresponds to quadri-chloro-tolan, $C_{14}H_{10}Cl_4$, is acted upon by zinc (the compound being placed in hot alcohol), so that half the chlorine is withdrawn and the quadri-chloro-benzyl split up into two compounds, which although of the same elementary composition, $C_{14}H_{10}Cl_4$, exhibit very different physical properties. One of these substances is a crystalline solid body, fusing at 153°, and difficultly soluble in boiling alcohol; the other is nearly soluble in boiling alcohol in every proportion, is also a solid body, has a different crystalline form, and fuses at 63°. Both of these substances are soluble in ether and acetic acid, and not further acted upon by zinc, but by the action of sodium amalgam both these bodies are, when dissolved in alcohol, converted into tolan; at 150°, the two bodies referred to are not acted upon by alcoholic solution of potassa.

No. 3, 1871.

Hydrological Researches.—Dr. C. Schmidt.—This very elaborate and exhaustive essay contains the following sections;—Water of the Glacial Sea, taken at 69° 55′ N. lat. and 49° 30′ E. long. from Greenwich; water of the Peipus Lake and of the rivers which feed it. This essay is copiously filled with the results of a large number of analyses of the waters alluded to, and these results are carefully compared with a lengthy series of results of analyses of fresh and salt waters made by other authors.

Eatable Earths from Lapland and Southern Persia.—Dr. C. Schmidt.—Dr. A. Göbel, while travelling in the summer (1870) in Northern Europe (67° 5′ N. lat. and 41° 12′ E. long. from Greenwich), obtained at Ponoi, a village situated on the White Sea, an earthy material which is used by the inhabitants as an addition to flour in bread-baking. A sample of this substance having been forwarded to the author for analysis gave the following percentical results:—Water driven off at 100°, 0·26; water driven off at low red heat, 0·885; alumina, 40·797; peroxide of iron, 0·310; magnesia, 0·618; lime, a trace; soda, 1·829; potassa, 9·845; silica, with a trace of fluorine, 45·506. From this result, as well as from the microscopical examination, the author concludes that this material is not fit for digestion at all. The Persian material was found in the district of Kirman, at 5000 feet above sea-level (30° 10′ N. lat. and 58° 10′ E. long. from Greenwich). The substance locally known as "G'hel i G'iveh" is met with in the shape of lumps of the size of an apple, is converted by the action of water into a soft slimy mass, and is very readily soluble in dilute acids, even in dilute acetic acid. The percentage composition of this substance was found to be:—Carbonate of magnesia, 66·963; carbonate of lime, 23·634; chloride of sodium, 3·542; sulphate of soda, 0·293; carbonate of soda, 0·598; hydrate of magnesia, 1·311; peroxide of iron, 0·092; alumina, 0·227; silica, 0·765; water of combination driven off at 120°, 1·153; hygroscopical water, 1·422. Since the inhabitants of the country here alluded to bake bread from flour which is fermented so as to become sour, the addition thereto of some of the powder of the mineral here alluded to will have the effect of a kind of baking-powder, and at the same time neutralise the acid.

On some of the Properties of Trimethyl-Carbinol.—Dr. A. Boutlerow.—Notwithstanding the high scientific value of this exhaustive memoir, its contents are not well suited for any useful abstraction; an observation equally applying to the following papers, which would also require the reproduction of very lengthy and complex formulæ:—

On Triethyl-Carbinol.—Dr. A. Nahapetian.

Dimethyl-Pseudo-Propyl-Carbinol.—J. Prianichikow.

On a New Body Isomeric with Amylen.—M. Ermolaiew.

No. 4, 1871.

The original papers and memoirs contained in this number do not relate to chemistry or collateral sciences.

NOTES AND QUERIES.

A Curiosity in Water Analysis.—The following amusing analysis of the "Chalybeate Springs" appears in page 10 of the "Concise Guide to Tunbridge Wells and Surrounding Neighbourhood," recently published, and sold everywhere in the town:—"The water is clear, bright, and colourless; the taste savours strongly of steel, but is not disagreeable, and it has scarcely any smell, though sometimes in a dense air its ferruginous exhalations are very distinguishable. When first taken up in a large glass, its particles continue at rest till it is warmed to nearly the heat of the atmosphere, when some airy globules begin to separate and adhere to the glass, and in a few hours a light copper-coloured scum begins to float on the surface, whilst an ochreous sediment settles at the bottom. From the experiments of different physicians, it appears that the component parts of this water are steely particles, marine salts, an oily matter, an ochreous substance, a volatile spirit too subtle for analysis, and a simple fluid." Perhaps some one of your readers could manufacture an artificial mineral water from the above analysis for the benefit of those unable to visit the springs!—J. J. M.

MEETINGS FOR THE WEEK.

Monday, Oct. 30th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "Elementary Physiology (I.)"

Thursday, Nov. 2nd.—London Institution, 7.30. Dr. J. H. Gladstone, F.R.S., on "Michael Faraday: the Story of his Life."

—— Chemical, 8. W. H. Perkin, F.R.S., on "Anthraflavic Acid."

TO CORRESPONDENTS.

*** Vol. XXIII. of The Chemical News, containing a copious index, is now ready, price 12s. 4d., by post, 12s., handsomely bound in cloth, gold-lettered. The cases for binding may be obtained at our office, price 1s. 6d. Subscribers may have their copies bound for 2s. 6d. if sent to our office, or, if accompanied by a cloth case, for 1s. Subscribers wishing to complete their sets of volumes are requested to apply to the publisher, who will give them information respecting scarce numbers and volumes. Vol. xxiv. commenced on July 7th, and will be complete in twenty-six numbers. Reading Cases, price 1s. 6d. each, post free, may also be obtained at the Office.

J. C.—Single numbers of the foreign journals cannot often be purchased, so that no object would be gained by our adopting the course you propose. A foreign bookseller will give you the subscription prices.

J. Instone.—You will find full particulars about testing carbolic acid in "On the Application of Disinfectants in Arresting the Spread of the Cattle Plague," by William Crookes, F.R.S. The price is 1s.; it can be had on application to our publisher.

BOOKS RECEIVED.

An Introduction to Practical Chemistry, including Analysis. By John E. Bowman, F.C.S., late Professor of Practical Chemistry in King's College, London. Edited by Charles L. Bloxam, F.C.S., Professor of Chemistry in King's College, London.

Report on Spiritualism of the Committee of the London Dialectical Society. London: Longmans and Co.

A Systematic Handbook of Volumetric Analysis. By Francis Sutton, F.C.S. Second edition. London: J. and A. Churchill.

On the Relative Powers of Various Substances in Preventing the Generation of Animalculæ, or the Development of their Germs, with Special Reference to the Germ Theory of Putrefaction. By John Dougall, M.D. London: J. and A. Churchill, New Burlington Street.

Sixth Report of the Quekett Microscopical Club, and List of Members.

New Remedies. A Quarterly Retrospect of Therapeutics, Pharmacy, and Allied Subjects. Edited by Horatia C. Wood, jun., M.D. New York: William Wood and Co.

Lecture on the Analysis of Coal-Gas. By Henry Letheby, M.B., M.A., &c. Delivered before the British Association of Gas Managers. London: William B. King.

The Use of Gas in the Laboratory.

NOTICE TO AMERICAN SUBSCRIBERS.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 623.

ON CERTAIN REACTIONS OF THE SULPHO-CONJUGATED ACIDS OF PHENOL.

By C. GIRARD and G. DE LAIRE.

MORE than a year ago, Messrs. Dusart and Bardy patented a process for the preparation of certain secondary monamines of the aromatic series. The process, which, according to its authors, was a general one, consisted in submitting a primary aromatic monamine to the action of the sulpho-conjugated acids of phenol. They quoted in particular the production of diphenylamine by the action of phenol-sulphuric acid or a phenol-sulphate upon aniline at a temperature of 200° to 230° C. According to these chemists the phenol loses its hydroxyle, the phenylic residue replacing one of the atoms of ammoniacal hydrogen of the aniline.

This reaction is in contradiction to what is known of the constitution of phenol and its sulpho-conjugated derivatives, and, moreover, we endeavoured some years ago, and always without success, to replace the available hydrogen in aniline by the phenyl radical contained in phenol.

The unexpected result announced by Messrs. Dusart and Bardy has induced us to undertake further experiments on this subject.

(1). We heated for two days in a closed tube at 250° to 280° one molecule of phenol-sulphate of sodium and one molecule of aniline. The tube contained at the end of the experiment a liquid and a solid portion. On opening it there was no evolution of ammonia; we observed only the characteristic odour of sulphurous acid. The liquid portion contained aniline and unaltered phenol; the solid portion was composed of sulphate, sulphite, and sulphide of sodium. We could discover no diphenylamine whatever, and with the exception of an insignificant loss of 2 or 3 per cent, the whole of the phenol corresponding to the phenol-sulphate was recovered.

(2). We repeated the previous experiment under the same conditions of time and temperature, but employing an *excess* of aniline, 2 or 3 molecules of aniline for 1 molecule of phenol-sulphate. On opening the tube there was a considerable evolution of ammonia and a strong smell of sulphide of ammonium. The contents of the tube were partially liquid and partly solid. The former was composed of aniline, phenol, and diphenylamine. The solid portion contained sulphate, sulphide, hyposulphite, and sulphide of sodium. These experiments, several times repeated, show clearly that the formation of diphenylamine is not due to the substitution of the phenylic residue in phenol for the ammoniacal hydrogen of the aniline, but simply to the action of aniline upon one of its salts.* This was to be expected on theoretical grounds, and has been thoroughly confirmed by experiment.

ON THE ESTIMATION OF ANTIMONY, AND THE SEPARATION OF ANTIMONY FROM TIN, FROM ARSENIC, FROM TIN AND ARSENIC, AND FROM THE OTHER METALS, BY MEANS OF A NEW PRECIPITATING REAGENT OF ANTIMONY.

By HUGO TAMM.

WITH the exception of sulphuretted hydrogen, there is no real precipitating reagent of antimony known to chemists; for although the number of reagents, both organic and inorganic, which precipitate this metal is very great, in every instance known the precipitation is incomplete, and a very large proportion of the metal remains in solution, so that all those reagents are unfit for the estimation of antimony.

It is a great pity, for some of them, such as water or oxalic acid, would be admirably adapted for this purpose. But analysts must submit to the whims of nature, over which they have no command whatever, and it is only by patient labour, untiring perseverance, and, above all, luck, that they can overcome practical difficulties.

One method being always insufficient for the estimation and the separation of a substance in all cases, if I propose a new process for the estimation of antimony it is not in view of substituting it to the method which has rendered such great services to analysis, but, on the contrary, to strengthen it by means of a powerful auxiliary, for accurate estimations and neat separations leading to trustworthy results and to complete analysis can only be obtained by the judicious use of several methods.

The process which I am going to describe will be found most useful in most cases, and sometimes absolutely indispensable.

It was neither chance nor analogy which led me to discover it, but I was sensible to the defects of the old methods, and thoroughly disgusted with the clumsy and generally difficult processes hitherto proposed for the separation of antimony from tin and arsenic, and I resolved to find out some simple means of estimating antimony, and of separating it from tin and from arsenic.

After a careful investigation of the precipitating properties of all the substances of which I could lay hold of, and which were likely to effect the object I had in view, luck pointed out to me the following method:—

Estimation of Antimony in the State of Bigallate of Teroxide of Antimony.

When a neutral and concentrated solution of terchloride of antimony is mixed with a slight excess of gallic acid, all the antimony is precipitated in the state of a double gallate of teroxide of antimony and water, or, to use the ordinary notation, as bigallate of antimony, or antimonious bigallate.

A neutral or slightly acidulated solution of terchloride of antimony, corresponding, in fact, to strongly acidulated solutions of ordinary metals, the precipitation of antimony takes place in a regularly acidulated liquor, since besides the free hydrochloric acid present, all the combined hydrochloric acid is liberated by gallic acid.

In this acidulated liquor, bigallate of antimony is almost completely insoluble, and in the liquor separated by filtration from the precipitate, sulphuretted hydrogen reveals but a minute quantity of antimony which can be neglected for most practical purposes.

In those conditions, antimony is the only metal precipitated by gallic acid. All the other gallates, even those which are insoluble in water, are extremely soluble in the liquor from which antimony has been precipitated, and, consequently, gallic acid affords an easy means of separating at once antimony from the other metals.

It follows, also, that gallic acid is a very perfect precipitating reagent of antimony; in fact, it has only one defect, it is a non-volatile organic acid, and as such, it alters the behaviour of some metals with some of their precipitating reagents, so that after the separation of antimony, it is sometimes necessary to precipitate by sulphuretted hydrogen or by sulphide of ammonium the metals left in the solution. But as this operation would, in many cases, have to be performed for convenience sake, it matters but very little. On the other hand, most metals can be precipitated, even in presence of an excess of gallic acid, by means of appropriate reagents, and I shall carefully indicate when and how this can be done, and when, on the contrary, the metals must be precipitated as sulphurets.

* French Patents; Girard and De Laire, March 21, 1866. *Moniteur Scientifique*, April 1, 1867; Feb. 1, 1868; Sept. 15, 1869.

Precipitation of Bigallate of Antimony; Washing, Drying, Weighing, Behaviour, and Composition of this Precipitate.—On a New Phenomenon called Hygraffinity.

As I have stated above, the solution of terchloride of antimony must be neutral or only slightly acidulated, and what is most important, the solution must be concentrated. The reason of this is obvious, for bigallate of antimony is partially or in totality soluble in hydrochloric acid, according to the quantity of this acid present in the liquor, and as it is well known, the weaker a solution of antimony is, and the more acid is required to keep it clear, while the more concentrated the solution of antimony is, and the more neutral it can be obtained.

After that a strong and neutral solution of terchloride of antimony has been prepared, only a slight excess of gallic acid should be added. To ascertain this, the following test is employed:—

After the addition of a quantity of gallic acid apparently sufficient to precipitate all the antimony, the precipitate is allowed to subside. A glass rod is dipped in the supernatant liquor, and a drop of this liquor is placed on a piece of white paper. To this a drop of ammonia is added, and the slightest excess of gallic acid present is indicated by the nice pink colour which appears.

If too much gallic acid had been used, this excess of acid would in no way impair the accuracy of the estimation of antimony, and if it is recommended not to use more of this acid than is required for the complete separation of antimony, it is chiefly to simplify the separations and estimations of the metals left in solution.

The solution of gallic acid used for the precipitation of antimony must be quite recently prepared; for in a solution of some days standing, gallic acid is altered by a peculiar phenomenon of hydratation, whereby it becomes unfit for the complete precipitation of antimony. That this alteration in the composition and the properties of gallic acid is only due to hydratation is proved by the fact that the solution evaporated to dryness leaves a residue of gallic acid, which, when re-dissolved in water, is perfectly fit for the complete precipitation of antimony. This phenomenon of hydratation is analogous to the phenomena exhibited by phosphoric acid.

Bigallate of antimony is a very white precipitate, somewhat bulky, but which settles very rapidly. It cannot, however, be washed on the filter, not even on a double filter, for it invariably passes through the filter as soon as the acidulated mother-liquor has been washed away. But as it settles very rapidly in liquors, the mixed mode of decanting and filtering must be resorted to, and in this instance this process presents no inconvenience and no difficulty. The only disadvantage is that more washings are obtained than would be the case with simple filtration. For this purpose, the precipitate is allowed to settle, the liquor is poured on the double filter and decanted as closely as possible from off the precipitate. This done, the flask holding the precipitate is re-filled with hot water, the precipitate is allowed to settle once more, and once more the supernatant liquor is filtered and decanted as closely as possible from the precipitate. The same operation is repeated three or four times; the precipitate is then placed on the filter, where it can be washed once or twice with safety.

The tedious description of this tedious operation has its importance, as, by following to the letter the indications here given, much trouble and inconvenience will be avoided.

The drying of gallate of antimony, with the usual precautions, is very easily effected in the water bath at the temperature of 100° C., and the formula of the precipitate thus thoroughly dried is then $SbO_3(C_7HO_3)_2 3HO$, and it contains exactly 40·85 per cent of metallic antimony.

In the estimation of antimony, the dried bigallate should be weighed as soon as it has cooled, or, better still, shortly after it has been left to cool in a dried atmosphere, for it has a great affinity for water, which it absorbs rapidly from the air.

When bigallate of antimony, dried at 100°, is left exposed to the air for a few hours, it is found to absorb exactly two equivalents of water, and its formula is then identical with that of bigallate of antimony dried at the temperature of 80° C., and which is represented by—

(1.) $SbO_3(C_7HO_3)_2+3HO$. (2.) $SbO_3(C_7HO_3)_2+5HO$.

This new bigallate of antimony is the normal compound; it contains exactly 38·77 per cent of metallic antimony, and it could be used as well as the other one for the estimation of antimony, but there is evidently no advantage in so doing.

When the bigallate of antimony dried at 80° C. is placed in the water-bath and dried at 100° C., it loses two equivalents of water, but on being left exposed to the air for some time it re-absorbs those two equivalents of water, which it loses by another desiccation at 100° C., and which it re-absorbs once more by a fresh exposure to the atmosphere.

This curious experiment can be repeated indefinitely with the same success, and this fact is so very remarkable that although I have the strongest objection to the introduction of new words in science, I have no alternative but to give a name to this extraordinary phenomenon, and I shall call it, for convenience sake, *Hygraffinity*, or *Chemical Hygrometry*, to distinguish it from physical hygrometry, as it is observed in artificial silica, oxide of copper, and a number of insoluble substances.

I believe that bigallate of antimony affords the first example of an insoluble precipitate exhibiting such a powerful affinity for water. I cannot believe that this example is unique, and I trust that it will be the basis of an interesting investigation of similar phenomena not yet observed in insoluble compounds, and I have no doubt that it will be among the organic insoluble compounds of metals that the most interesting facts connected with this phenomenon will be discovered.

The estimation of antimony in the state of bigallate dried either at 80° C. or at 100° C. is very accurate indeed when the precautions indicated have been observed. But it is not absolutely necessary to estimate this metal in this state, even after it has been separated as bigallate, for, as I have stated before, bigallate of antimony is extremely soluble in weak hydrochloric acid, so that, after it has been placed on the filter, it is only necessary to dissolve it in hydrochloric acid, to wash well the filter with dilute hydrochloric acid, and to precipitate the solution thus obtained by sulphuretted hydrogen, to be enabled to estimate antimony as usual in the state of tersulphide. The sulphide of antimony obtained in these conditions is chemically pure, and all that is required to apply it to the estimation of antimony is to wash it well until the washings mixed with a little ammonia exhibit no pink colour indicative of the presence of gallic acid.

On the whole, it is, perhaps, best to follow, as a rule, this last process, but it must be resorted to when the analyst has not got at his disposal the proper appliances for drying and for cooling the bigallate of antimony.

Remarks.—When antimony has been estimated as bigallate, or separated in this state from metals insoluble in sulphide of ammonium, an excellent precaution to take to ascertain the perfection of the separation is to dissolve the bigallate of antimony which has been used for the estimation of antimony in an excess of sulphide of ammonium.

There ought to be no residue of black sulphides insoluble in this reagent.

Preparation of the Solutions of Terchloride of Antimony required for the Separation and Estimation of Antimony in the state of Bigallate.

Were it not for the remarkable reaction which I am going to describe, gallic acid could be used only in very limited instances,—in those only in which the antimonial

compound dissolved in hydrochloric acid gives at once a solution of terchloride of antimony, for solutions of perchloride of antimony are quite unfit for the estimation of this metal by gallic acid, and most reducing reagents act very indifferently on perchloride of antimony, or do not act at all, or are the means of introducing in the solution substances difficult of separation, and which, as a rule, disturb known reactions, and prevent, in most cases, neat separations and accurate estimations. But when a solution of perchloride of antimony, slightly acidulated with hydrochloric acid is mixed with iodide of potassium, two equivalents of chlorine combine with two equivalents of potassium; two equivalents of iodine are liberated and the perchloride of antimony is reduced to the state of terchloride, $SbCl_5+2KI=SbCl_3+2KCl+2I$.

This important reaction will prove most useful, as by its means perchloride of antimony can, at will, be converted into terchloride with the utmost facility, by the introduction of two substances, one of which, iodine, is evolved, the other, potassium, remaining in the liquor, and aiding, as I will show, to the accuracy of the estimation. Consequently, whenever there is the slightest doubt about the composition of a solution of antimony obtained by some means or other, it is only required to heat the solution with a slight excess of hydrochloric acid and a little powdered iodide of potassium. When no iodine is evolved, it is because the whole of the antimony exists in the state of terchloride; when, on the contrary, iodine is evolved, it is because part or the whole of the antimony exists in the state of perchloride, and it is only necessary to add iodide of potassium little by little until no more free iodine is evolved to be certain that the whole of the antimony is reduced to the state of terchloride.

In general it is useless, and it may sometimes be inconvenient, to add more iodide of potassium than is required for the complete reduction of perchloride of antimony, but with a little experience nothing is easier than to judge when the proper quantity of iodide of potassium has been added. This is invariably the case when the clear liquor freed from iodine and mixed with a little more iodide of potassium remains clear, is not deeply coloured, or evolves no more free iodine.

The solutions of terchloride of antimony thus prepared and properly concentrated by slow evaporation are then quite ready to be precipitated by gallic acid.

Estimation of Antimony in Native Sulphuret of Antimony.

The estimation of antimony in this important mineral is very easily effected by means of gallic acid, and its complete and accurate analysis, which was very difficult and almost impossible by the old methods, has become quite simple by the gallic acid process.

Twenty grs. of the powdered mineral are treated by a slight excess of hydrochloric acid, and the mixture is gently heated until the whole of the sulphuretted hydrogen disengaged is thoroughly evolved. The solution is then filtered, the filter and matrix are washed with dilute hydrochloric acid, and the solution is slowly evaporated in the flask until it is conveniently concentrated and freed from the excess of hydrochloric acid.

In this solution the whole of the antimony exists in the state of terchloride, a slight excess of a recently prepared solution of gallic acid is added, with the precautions already indicated. Hot water is then added, and the precipitate of bigallate of antimony is washed, dried, and weighed, as has already been stated. Antimony may also be estimated as sulphide after having been separated as bigallate.

Twenty grs. of this mineral are quite sufficient for the estimation of antimony, but in the complete analysis it would be inconvenient to operate upon more than 50 grs. as the precipitated bigallate of antimony is very bulky.

Antimony being separated as above, iron, lead, copper, silver, arsenic, and sometimes zinc, cobalt, and other metals remain in solution.

Arsenic exists much less frequently than is generally supposed, and I really do not know to what to attribute the universal belief that arsenic follows antimony everywhere, except to the imperfect or difficult methods hitherto employed for their separation, leaving a wide scope to the imagination of analysts.

Copper, on the contrary, is very often present. It can be estimated here with the greatest accuracy, as the whole of it exists, or may be made to exist, in the filtrate. By the old methods, on the contrary, it was constantly hidden by antimony which it followed in the successive operations of the analysis, since it was precipitated along with antimony, and nearly all taken up by the sulpho-antimoniate of ammonia formed by treating sulphide of antimony by sulphide of ammonium.

Although it was then possible to detect copper by attacking sulphuret of antimony by nitric acid, a large portion of copper was maintained in an insoluble state by the antimonic acid formed, so that it was not possible to estimate it with anything like accuracy.

The analysis of the filtrate is proceeded with as that of an ordinary liquor containing the metals mentioned. The only metal which cannot be properly estimated in this liquor is iron, the presence of gallic acid preventing its precipitation, even by means of sulphide of ammonium, but its complete separation from antimony is so simple by the known methods that I need only mention this fact, remarking, at the same time, that in this, as in most instances, one method is insufficient, and that correct analyses can only be made by the judicious use of several appropriate methods.

Estimation of Antimony in the Artificial Sulphide of Antimony in the Course of Analyses.

In the course of a complicated analysis, it is oftentimes absolutely necessary to obtain antimony first in the state of a sulphide of antimony mixed with a large quantity of sulphur, and contaminated with small, or, as the case may be, large, proportions of sulphides of copper, arsenic, or tin.

The gallic acid process affords a simple means of carrying out a careful analysis in this part of the operation, and of estimating antimony by a direct process.

For this purpose the collected mixture of sulphur, sulphide of antimony, &c., &c., wet or dried, is first of all treated by hydrochloric acid, and when the action has ceased a little chlorate of potash is added, to attack any copper or arsenic which might have escaped the action of the acid. The solution thus obtained decanted from off the residue of sulphur is evaporated, reduced by iodide of potassium, and precipitated by gallic acid. In all this the mode of proceeding is identical with the process fully explained in the next example.

(To be continued)

REPORT ON THE

MOLECULAR DISSOCIATION BY HEAT OF COMPOUNDS IN SOLUTION.

By CHARLES R. C. TICHBORNE, F.C.S., M.R.I.A., &c.

(Continued from p. 203).

Experiment 11.

THE addition of alkaline salts to the ferric compounds determines more easily the precipitation or dissociation. Therefore, the iron alums, either with the ammonia or potash base, exhibit this phenomenon in a marked degree. These alums, which show a beautiful but very faint amethyst tint, gave on solution in the cold a slightly coloured liquid, made paler on the addition of a very dilute solution of sulphuric acid. The gradual increase of temperature brought about all the reactions and phenomena

observed in the above experiments, only in a much more marked and decided mannner, whilst, again, this lowering of the thermanalytic point was even more evident with the potash alum.

It is unnecessary to detail the experiments performed with the solutions of ferric chloride, because the results were almost the same. I would wish, however, to observe, that even on prolonged boiling there seems to be no loss of HCl *at ordinary atmospheric pressure.*

It having been determined that the first results of the continuous boiling of a neutral ferric salt is the precipitation of a basic salt, containing a part of the stylous element, further experiments were performed to determine how far these acid molecules were removable at ordinary atmospheric pressure, by the combined and continuous action of water and heat.

Experiment 12.

A large quantity of a dilute solution of ferric sulphate was submitted to continuous boiling until a considerable precipitate was obtained. This precipitate was collected upon a filter, washed once and dried at 100° C. 0·219 grm. gave 0·141 of ferric oxide when dissolved in HCl, precipitated with ammonia, and weighed after ignition. This corresponds to 64·4 per cent of ferric oxide. A portion of this precipitate before drying was placed in a considerable body of water, and again submitted to a temperature of 100° C. for two hours. After this treatment the appearance was much changed; the colour which was originally of a light ochrey yellow, had been changed to a reddish-brown, whilst the precipitate became much denser. 0·388 grm. now gave 0·32 grm. on precipitation, as in the previous estimation, and therefore corresponds to 82·5 per cent; it, however, still contained a trace of the basic salt. The further action of heat upon these basic salts will be found described in Experiment 16.

It must be borne in mind that all the above experiments had been performed with what we might call chemically neutral salts, but it is probable that from a geological point of view there would be formed $Fe_2'''^{2a}_{3}$, or a deficiency of one-third of the acid, *e.g.*, from the oxidation, for instance, of iron pyrites. In such a case we would have to start with a basic solution, the first result of the oxidation of the pyrites being a ferrous salt, which ultimately becomes oxidised into the ferric.

Experiment 13.

To a weighed quantity of pure crystallised ferrous sulphate a quantity of pure nitric acid was added, sufficient to exactly oxidise the ferrous salts to its higher term. The acid was allowed to remain in contact with the powdered salt without the addition of water, until on dissolving a portion, and after warming and testing with ferricyanide of potassium, all trace of the magnetic salt had nearly disappeared. This product was then diluted with 50 times its weight of water: such a solution is perfectly clear, and will remain so for some little time, but ultimately it decomposes spontaneously at ordinary temperatures, the time being determined by the amount of dilution and temperature. When diluted so as to represent 0·5 per cent, a given volume (*a*) of this liquid gave on precipitation with ammonia and on ignition 1·557 grms. of ferric oxide. In a second determination, the solution was brought to 100° C., and maintained at that temperature for some time; the precipitate that fell was separated from the liquid by filtration, washed with a small quantity of water, and dissolved in hydrochloric acid, and the oxide estimated in this solution with ammonia, as in the first instance. 0·559 grm. was procured, which is over the amount of base really in excess of the acid present, $\frac{a}{3}$ = 0·519 grm. The filtrate again on dilution and boiling gave a precipitate representing 0·049 grm. of oxide. The filtrate again on dilution and boiling became opaque, but it was not necessary to follow out this experiment further, it being evident that there was no actual limit. It is probable that many of the ores, such as hæmatite, brown iron ore, bog iron ore, ochres, &c., are formed in somewhat a similar manner to that detailed, and it is curious to observe that sulphuric acid is seldom absent from such hydrated minerals and frequently in much larger quantities than the published analyses would lead one to suppose (*vide* Analyses).

We have now to consider the action of heat upon such fluids under pressure.

Experiment 14.

A solution of ferric sulphate was placed in a tube of hard German glass* and hermetically sealed. This tube was then placed in a gun-metal apparatus, capable of bearing a considerable pressure, a little water being placed in the apparatus to equalise the pressure outside the glass tube, the heat was gradually raised until a thermometer, the bulb of which was placed in a cavity outside the apparatus, marked 177° C. The whole apparatus was maintained at this temperature for two hours. On cooling and taking out the tube, it was seen that a similar decomposition had taken place as that obtained under ordinary atmospheric pressure, only in a more marked manner. At the bottom of the tube there was a considerable precipitate of an ochry nature, consisting of basic sulphate; but at the surface of the fluid there was an incrustation composed of red oxide of iron, adhering to the side of the tube in the form of a ring.

Experiment 15.

This was a modification of the previous one, but in this case a more volatile stylous element was chosen, and although it was placed in a tube, as in the previous experiment, the orifice was left unsealed. We were, therefore, on placing it in the apparatus described above, submitting the fluid to the action of a considerable volume of steam, at a pressure of nine atmospheres. After two and a half hours' digestion the contents of the tube presented a remarkable appearance. The greater part of iron lay at the bottom of the tube, not in the form of a basic precipitate, but as a dark and heavy oxide of iron. Thin layers of this oxide adhered to the tube at the surface of the fluid, which, when examined by the microscope were seen to be transparent and brilliantly red; by reflected light they possessed a blackish metallic lustre. The tube still contained an acid salt of iron, which, however, no longer acted upon the enclosed oxide; the latter seemed anhydrous.

In the first experiment (Expt. 14) there can be no doubt that a similar change had partially taken place, but only to a slight extent; it was the limited volume of steam generated in the tube reacting upon the surface of the fluid that formed the ring of ferric oxide. Certain specimens of specular ore (Analysis 4) are formed in this manner. They are simply pseudomorphs of the sublimed and anhydrous ferric chloride, produced by volcanic agency, and ultimately submitted to the action of high pressure steam.†

Experiment 16.

The basic precipitate procured upon boiling a solution of ferric sulphate at ordinary temperatures, was next placed in a tube with a little water, and submitted to the action of steam for two and a half hours, at a temperature of 177° C. The result was the gradual conversion of the basic precipitate, which lay at the bottom of the tube to the extent of about 15 millimetres, into a bright red and dense precipitate, which, however, gradually assimilated its original appearance until, at the depth of 6 millimetres, it appeared to have retained its primitive

* It is necessary in these experiments to have a good glass, as some specimens of lead glass seem to be rapidly acted upon at high temperature by some of the solutions used.

† In speaking upon this subject in his Lectures on Chemical Geology, Dr. Percy says, "Supposing we have the vapour of sesquichloride of iron, there is no difficulty in accounting for the formation of this sesquioxide in volcanic regions. If that vapour be brought in contact with the vapour of water, we get a deposit of crystallised sesquioxide of iron, with the formation of hydrochloric acid."

composition and ochry appearance. Some considerable proportion of this precipitate seemed to have been carried up the side of the tube. At the line of juncture of steam and fluid, this precipitate was converted into anhydrous oxide of iron; above this the basic salt was intact, except that it seemed to be perfectly dehydrated and white, and it was not until it had been in contact with the fluid contained in the tube that it seemed to regain its original appearance. It is evident, therefore, that as regards the more fixed and non-volatile acids no dissociation is effected at the temperature tried, except in the presence of condensed water, but that the steam is capable of removing water of hydration under such conditions.

Before disposing of these experiments I should wish to draw attention to some speculations upon this subject which have been promulgated by Dr. Percy in his lectures on Chemical Geology.* "It" (ferric oxide) "is found pseudomorphous after iron pyrites. It is a puzzle to know exactly how this pseudomorphism has taken place. "If iron pyrites is exposed to the weathering action of the air, it is converted, and must be converted first of all into a common sulphate of protoxide of iron, that becomes oxidised by exposure to the air, passing to the state of a sulphate of sesquioxide of iron. That sulphate of sesquioxide of iron, by the action of water, decomposes into two salts—an acid salt which will dissolve away, and a more basic salt which would remain. We can easily understand the transformation of iron pyrites, under these conditions, into a highly basic sulphate, and even into hydrated sesquioxide, because we have only to call into our aid bicarbonate of lime, which frequently occurs in mineral waters. The trace of sulphuric acid might be easily removed, and the gypsum formed washed away, leaving nothing but hydrated sesquioxide of iron in the manner described, and then exposed to a certain degree of heat whereby the water of the hydrate may be expelled, and the red oxide left. But that theory will not suffice, because we find certain crystals of hydrated sesquioxide of iron which are partially converted on the outside into red oxide of iron. It is perfectly evident that the temperature sufficient to decompose the hydrate could never have existed when such crystals were formed, because if it had, it is impossible to conceive that any nucleus of hydrated sesquioxide of iron should remain. The formation of this anhydrous sesquioxide of iron in nature is yet unexplained satisfactorily. We can produce it readily enough in our laboratories by means of heat, but there is no reason for supposing that in the condition in which it has been produced in nature, a high temperature has prevailed, or, at least, that remark applies to many cases of the formation of that mineral."

As regards the ultimate removal of the sulphuric acid, it would seem from the experiments detailed, that it is not absolutely necessary to call in the aid of a second base, such as lime, it being quite possible and probable that the same results may be obtained, under the laws of dissociation, by the aid of immense pressure and a long period of time, such as would be procured in geological changes.

Again, as we see that we can have perfect dehydration even in the presence of water or steam, the second difficulty which presents itself in the crystals of anhydrous oxide containing the nucleus of hydrate is disposed of.

The chromic oxide behaves exactly in a similar manner, except that, *cæteris paribus*, the point of dissociation is higher, and therefore it requires more careful investigation to observe the changes produced by heat upon its compounds in solution, which so far have escaped observation or have been misconstrued.

It is well known that the ordinary chromic salts present a "peach blossom" colour when in solution, convertible by heat into green solutions. The most rational of the many explanations given of this phenomena is one of dehydration, but there is something more than this. Theoretically, it would seem that the chromatic change was due to basicity of the solution as in the ferric salts, and that it was only necessary to increase the boiling-point of the solution by pressure, or to increase the condition of basicity by the volume of water to obtain similar results to those obtained with iron. This was satisfactorily verified with many experiments, a few of which will suffice to illustrate this part of my subject.

Experiments 17 *and* 18.

Solutions of chromic sulphate and potassio-chromic alum, when submitted in tubes for the space of two to three hours in the pressure apparatus, gave, in each case, basic precipitates, the temperature being 177° C. The precipitate in the last-named substance being very voluminous, I did not succeed in procuring anhydrous chromic oxide corresponding to the ferric oxide, but look upon its consummation as merely a matter of pressure.

Experiment 19.

A dilute solution of any chrome alum, if dropped into a flask of boiling water, is instantly dissociated. The contents of the flask become quite opaque, and the basic precipitate is palpable to the eye. This precipitate is redissolved on cooling, and even during boiling if the solution of chromic alum is gradually added.

If we accept the theory, of which there can be little doubt, that there can co-exist a base and an acid salt in solution, this explains at once the change of violet salts of chromic oxide into green solutions on boiling. Any neutral salt of chromic oxide dissolved in the cold gives a violet colour contaminated with green ("peach blossom"?). This, as in the iron salt, is due to the basylous action of the water. The cautious addition of dilute sulphuric acid converts it into nearly a pure violet. It is converted into the green solution either by the addition of an alkali, by the addition of water, or by heat. In other words, the green colour in chromic salts is due to the basylous condition. In the case of heat, the green solution regains, after some time, its original condition, but only slowly. Many explanations have been given of this phenomenon, and it seems almost strange that one so simple should have escaped observation.

The aluminic oxide also obeys the same law of dissociation, only in a still less marked manner. It was evident that from analogy this should be so, although at the first glance it would appear that such was not the case. But, on taking into consideration the relative atomic position of the elements concerned, it would be seen that dissociation could be only exerted at ordinary pressures to a very limited extent as regards this base; thus there is no evidence of decompositions in solutions of any considerable strength on boiling, but if a very considerable proportion of water is there to the amount of salt, a basic compound thereof is precipitated at 100°C. This is best seen by passing a beam of electric light through the flask, as the precipitate formed is almost optically invisible in daylight. A beam of electric light impinging upon the light flocculent precipitate at once reveals its existence. It is almost absolutely necessary to use some such light when operating upon chloride of alumina, but an aluminic alum, by virtue of the extra play of affinities brought to bear, gives a reaction easy of observation by the eye: these precipitates re-dissolve on cooling. As regards the effects of extraordinary heat procurable under pressure, we find that alumina behaves in a similar manner to the other members of this group, which the following experiments will illustrate.

Experiment 20.

The ammonia and potash alums were placed in separate sealed tubes, and submitted for 2½ hours to a temperature of 177° C. White crystalline precipitates were produced, varying in composition, but containing sulphuric acid. They represented the greater part of the alumina present

Experiment 21.

An open tube containing a solution of chloride of aluminium was placed in the same apparatus (described in

* CHEMICAL NEWS, vol. ix., p. 147.

the iron experiments) and submitted for some hours to a temperature of 177° C. At the line of juncture of fluid and steam a white colloidal substance was deposited, which seems to consist of a mixture of hydrated and anhydrous alumina. This experiment may throw some light upon the formation of corundum. Sapphire, ruby, and topaz have been formed artificially with perfect success by Ebelmen, Deville, and others; all these artifical processes, however, have been igneous ones. In nature, however, it is evident that the corundum is not always, if it is ever, formed in this manner. It frequently contains from 3 to 4 per cent of water, and is also associated with diaspore and other hydrated minerals.

Before concluding this part of my report, I will consider for a moment the results of these experiments collectively. It would seem that the compound molecules of aluminic, chromic, and ferric oxides are dissociatable in ratio to their atomic weight; or, we may say, as regards this group, that their basylous position is in ratio to their dissociatability. Thus, although compound alumina molecules are dissociatable at ordinary temperatures when insufficiently dilute the decomposition is not so well marked until we get an extraordinary pressure, and the corresponding increase in the range of temperature. Again, that in the presence of other compounds of basylous elements they are more easily dissociated from the introduction of a second basylous molecule reacting upon the acid. The following series of experiments upon the alums and simple salts will place what is stated in a clearer light. Some of them were performed by taking very diluted but standard solutions of the typical salts and adding, degree by degree, to them, whilst in a state of ebullition, water until the thermanalytic point was reached; they were so arranged that the evaporating water was re-condensed and flowed back into the flasks. The water was distilled twice, the first time from a small quantity of acid sulphate of potassium to render it free from all trace of ammonia. The flasks were made of hard German glass, and were digested with dilute hydrochromic acid for some time before they were used. It was found impossible to obtain water by filtration through paper that would stand the test of a beam of the electric or lime-light. The clearest water was obtained by subsidence after distillation from a silver retort. Except in a few cases, most of the experiments can be followed by performing them by gas-light. The flasks must, in this case, be carefully cleaned, and a powerful gas-flame be placed opposite the manipulator and behind the flask. The faintest precipitate will be perceived by this means on holding the flask close to the eye, providing it is not of that peculiar transparent and colloid nature sometimes observed in modifications of alumina and silica.

The solutions used were weak, but were so proportioned that each contained an equivalent quantity of the trioxide to correspond to 1 grm. of chloride of aluminium dissolved in the ½ litre of water; the exceptions were in two of the iron experiments. The following were the results:—

Expt.	Salt used.	Weight used, or equivalent to 1 grm. of $AlCl_3$ in ½ litre H_2O.	Temperature at which dissociation sets in.	Degrees c.c. of dilution required to produce decomposition with 1 grm. $AlCl_3$ and its equivalent.
			Degrees C.	C.c.
22.	$FeNH_4 2SO_4 12H_2O$	3·597	53·5	9·5
23.	—	with 1 vol. more H_2O	48	—
24.	—	with 2 vols. more H_2O	43	—
25.	$FeK2SO_4 12H_2O$	3·753	50	8·0
26.	—	—	43	—
27.	—	—	42	—
28.	$CrCl_3$	1·186	—	55001
29.	$CrK2SO_4 12H_2O$	3·727	—	2751
30.	$AlCl_3$	1·000	—	56251
31.	$AlNH_4 2SO_4 12H_2O$	3·384	—	31260

The observations recorded in these experiments can only be considered exact from a relative point of view, as there were too many contending influences to warrant the figures being taken as individual observations. They, however, conclusively prove the following points:—The relative position that the molecules, ferric, chromic, and aluminic oxides, hold, as regards dissociation, also the laws that govern their dissociation in the presence of other salts. Thus, the alums of the ferric oxide which have been chosen to determine this point are seen to obey the chemical laws of affinity. As regards the disturbing molecule introduced, its power of substitution determines the lowering of the thermanalytic point. Also the basylous power of this atom determines the amount of decomposition. Where the trioxides alone replace the hydrogen in the acid, the molecules are held together with a force in ratio to the relative affinities, but when a second molecule comes into play, a power of determining or lowering the thermanalytic point is found in the disturbing basylous element introduced. Thus we find in the alkali group, potash acts more forcibly than ammonia; in fact, they act in this respect according their power of substitution.

As before stated, the ferric salts have been experimented upon by M. Debray*.

That experimenter says—"Je ne suppose pas que le chlorure de fer se dédouble en acide chlorhydrique et en chlorure basique, parce que l'existence de ces composés basique soluble, en tant que composés definis, en parait peu conciliable avec le fait de leur decomposition par le filtre dans l'appareil dialyseur, ou par le sel marin qui en precipite de l'oxyde de fer pur. Il en parait plus natural de considerer ces composes comme des dissolutions de l'oxide colloidal de fer dans l'acide chlorhydrique ou tout au moins dans le sesquichloride de fer ordinaire." Now, although M. Debray's views are in the main correct, we cannot conceive that the *action of the dialyser* can have anything to say to the actual condition of the solution before dialysis. Immediately that we bring a *septum* into play we introduce another decomposing influence to bear and entirely modify the balance of the forces at work. I hope shortly to be able to demonstrate that not only the oxides of the group, we have been considering are capable of existing in either the colloidal or crystalloidal condition, the modifying agent appearing to be, in some instances, the combined water. There can be little doubt that at elevated temperatures we get a partition of the acid, so arranged as to give an acid salt and a basic salt, and that the amount of basicity is dependent not upon temperature, which only determines a constant decomposition for each degree, but upon relative volume of water, and, when we come to extraordinary pressure, relative volatility of the stylous molecules in the presence of steam. M. Debray again says—"Le chlorure de fer se dédouble donc à une temperature de 70 degrees en acide chlorhydrique et en sesquioxide de fer soluble dan l'eau," &c. All through his paper he speaks of this thermanalytic point, as I will call it, as a constant quantity for the same salt under all conditions. Now this involves a principle, and I have proved this point at a given pressure is entirely dependent as regards this group (and therefore as regards M. Debray's experiments with ferric oxide) upon the relative volume of water.

So sensitive is the potassio-ferric alum that a fine amethyst-coloured crystal obtained by crystallising it at a low temperature, when placed upon the palm of the hand, first becomes white and after a short time yellow. This salt is, of course, the most sensitive of all the group mentioned in this paper.

It may be well to point out that these experiments can only determine the laws of dissociation practically to a limited extent. We must build upon them, and conceive in our mind's eye the enormous results that are attainable with the aid of unlimited time and pressure.

* "Note sur la Décomposition des sels de Sesquioxide de Fer," par M. Debray.—*Comptes Rendus.*

We are compelled to bring into play the "scientific use of the imagination" and bridge over the long gap that lies between our mimic results and those consummated in the laboratory of nature, and by this means to mentally extend our experience. The results are here, but the *modus operandi* is absolutely a sealed book.

I propose to reserve the consideration of the element silicon, more particularly in connection with the bases dealt with in this paper. This will form a second part, as I wish in an immediate one to consider the conversion of these molecules from the crystalloidal to the colloidal condition.

(To be continued).

A NEW METHOD OF QUANTITATIVE CHEMICAL ANALYSIS.*

In comparing together the results of a large number of chemical analyses it is seen that the numbers obtained vary between 99·17 to 100·67, giving a difference of about 1·5 per cent, or, supposing a quantity of 1·500 grms. of substance has been taken and the weighings carried to 0·0001 grm., a difference of 225 units. The analyses here alluded to are by no means those which would be called bad or indifferent, but are such as have been made and published by eminent chemists. It ought further to be remembered that very many analyses yield results varying from 97 to 102 per cent, instead of 100, whilst the really bad ones never see the light at all. Under ordinary circumstances slight differences do not usually affect the result of an analysis, but if it is desired to employ the sum of the substances found to control the results, an incorrect total fails to serve this purpose, as there is no means of knowing upon which of the substances the error really falls. Moreover, in many instances, only small quantities of material are available. A more accurate and improved method of analysis would admit of the employment of smaller quantities as well as effect a great saving of time and labour.

It would appear that neither the methods and processes in use nor the impurities of reagents are greatly at fault, because it is found that, when the same substance is analysed under exactly the same conditions, the results often differ. It would, therefore, appear that accuracy depends chiefly upon the manipulations, among the most dangerous of which may be mentioned decantation, the removal of substances from a filter, the ignition of the filter-paper, and the calculation of the ash; the employment of a great number of vessels may either add something to solutions or withdraw something therefrom.

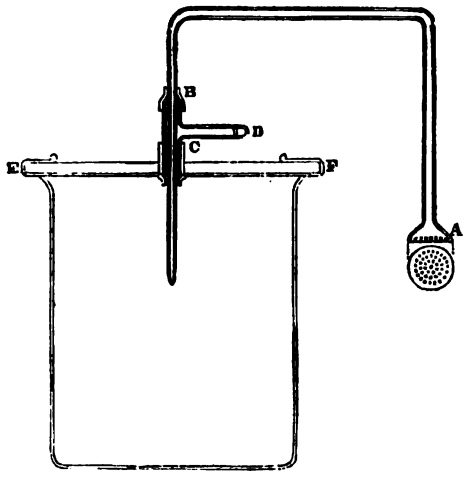
Dr. H. Carmichael has proposed a very ingenious apparatus for overcoming these difficulties. His apparatus is represented in the accompanying cuts.

Fig 1, represented one-fourth of its natural size, consists of a doubly bent glass tube, with a funnel-shaped widening at one of its ends, the wider part being perforated with a large number of small holes; the other bend of the glass tube is fitted in the T-shaped tube, B C D, closed air-tight at B, by means of a vulcanised india-rubber ring; the tube is fastened in the glass plate, E F, and fitted air-tight by means of a similar contrivance to the one just mentioned; E F is covered with a cap made of vulcanised caoutchouc, while between B and C a tube is fitted laterally, bent at D, at right angles (this part is not represented in full in the cut) and fitted with a small bored vulcanised india-rubber tube closed by a spring clamp. The cap and the ring, B, should be touched with some grease. The edges of a beaker can be readily rubbed on a piece of fine grained and thoroughly smooth and level sandstone, to take off the vitreous glaze, so that a plate of ground glass may fit quite tight thereon; this having been done the cover, E F (a ground glass plate), may be fitted so tightly that it is possible to keep in the interior of the beaker-glass as good a vacuum as in the receiver of an air-pump.

The filtering bulb, A (Fig. 2), being the most essential portion of this apparatus, its construction requires the greatest possible attention, and should be managed as follows:—

Take a glass tube having an inner bore of 2 m.m., blow at one end a thick bulb (see A, Fig. 1), flatten the bulb

FIG. 1.



at the bottom, keep this bulb so hot that the glass is only slightly soft, and while in that condition make holes in it by means of a white-hot steel wire; these holes should be close together, and not larger than 0·7 m.m. The width of the edge, *a b* (Fig. 2), differs according to the kind of filtering-paper which it is intended to use. For ordinary filtering-paper the width should be 3 m.m., for Swedish paper a width of 2 m.m. is sufficient; the perforated glass knob thus obtained is also ground slightly on sandstone.

FIG. 2.

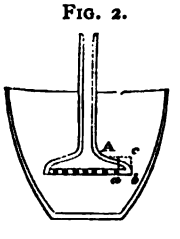


FIG. 3.

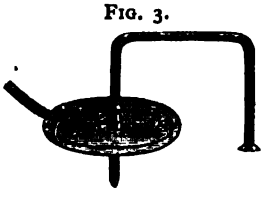
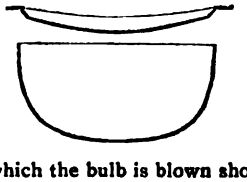


FIG. 4.



The tube to which the bulb is blown should be so bent as to make the leg B somewhat longer than the leg A; the height of the bulb must not be great, that is to say, it should be sufficiently flat to carry along with the air at the end of the filtration all the liquid into the beaker. The most suitable diameter of the bulb for general use is 2·5 c.m., the number of holes ought to be 50, but a smaller number will do when the holes are connected together by means of small channels cut in the glass by means of hydrofluoric acid. The apparatus is connected with an air-pump by means of a strong india-rubber tube. The

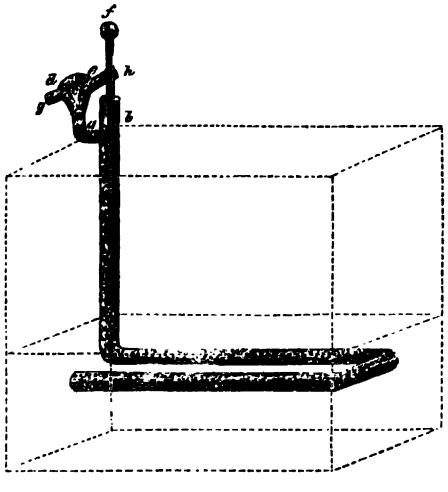
* From "Select Methods in Chemical Analysis," by William Crookes, F.R.S., &c. London: Longmans and Co.

best air-pump is formed by the human lips, but direct experiments have proved that the power of suction of men varies from 10 to 695 c.m. of mercury, that is to say, from $\frac{1}{76}$ to $\frac{1}{1}$, of an atmospheric vacuum. When the operator cannot suck above $\frac{1}{4}$ atmosphere, or when disagreeable gases are to be worked with, the Sprengel pump or the aspirator should be used. Even when full atmospheric pressure is on, the thinnest filtering-paper will not be broken.

In order to use the apparatus the air is pumped out, water being poured simultaneously on A. The rapidity of the current thus called into play effectually removes all impurities, and the water serves also to clean the beaker. This having been done, a circularly cut piece of filtering-paper, of the same diameter as A, is pressed against A. It remains fixed there, even when the apparatus is blown into; a vacuum is again made while the filtering disc is placed in the solution of the substance to be analysed, care being taken not to let the disc touch the bottom of the vessel in which that solution is contained; as soon as the solution is filtered off from the sediment, some pure water is added, the vacuum being still maintained, after which the apparatus, with the precipitate adhering to it, is removed from the vessel in which the solution was contained, while any sediment therein remaining is transferred by careful manipulation into a previously tared crucible.

Fig. 3 exhibits the mode of the connection of the apparatus with the air-pump. The bulb is placed in the vessel, and distilled water added for the purpose of washing the

FIG. 5.



sediment thoroughly, the water running into the beaker (the vacuum being kept on) for the purpose of drying the precipitate by the current of air. This may be carried so far as to cause even gelatinous precipitates to shrink together. The spring clamp now being opened, air is admitted to the beaker, and the filtering tube removed from the crucible as well as from the cover, E F. If the operation has been properly managed, the disc of filtering-paper remains on the top of the precipitate, the upper surface of the bulb remains clean, while only a very thin and small ring of the substance adheres to the lower edge of the bulb; this substance is removed by carefully holding a piece of filtering-paper flat in the hand and pressing it gently against the bulb; turn the latter gently so as to rub all the substance on the paper, which, with the substance thus fastened to it, is thrown into the crucible. This having been done, the crucible covered with its lid, is placed in an air-bath and heated to 105°. At this temperature the precipitate becomes readily and rapidly dry, without any danger of spirting; after which the crucible is ignited, first without the cover, until the very small quantity of paper is consumed, and afterwards with the lid on.

Although a bulb of the size above named is sufficiently large for many substances, it is preferable to have another bulb of 3·5 c.m. diameter for use with such gelatinous precipitates as alumina and peroxide of iron. Instead of the platinum crucibles in ordinary use, it is for this purpose preferable, though not indispensable, to use a platinum dish and cover, shaped as shown in Fig. 4, and weighing about 28 grms.

As the rapidity of the operations by this method makes it desirable to heat several crucibles at a time to 105°, and since this requires an air-bath with a really good gas regulator, those hitherto contrived being either of no use or somewhat expensive and too complicated, Dr. Carmichael has contrived the apparatus shown in Fig. 5. Anyone who has acquired some practice in glass-blowing may make it for his own use. Take a glass tube, 40 c.m. long and 0·6 c.m. interior diameter, bend it as shown in the woodcut so as to admit of two of the bends being placed below the false bottom of the air-bath, and the third, the vertical bend, to pass through an opening out of the bath, but so as not to touch the metal the bath is made of; at A, a glass tube of 2 m.m. interior diameter is melted on the wider tube, and shaped as shown at *c*; this narrower tube is branched off into two parts, each so bent as to be on a level together. At *d* and *e* holes are made in these branches in such a manner as to form small nipples towards the outside, which are next nearly closed, and then connected together by means of an india-rubber tube; the lower end of the wide glass tube is sealed, and the top opening closed with a cork, into which, through a carefully made hole, a thin and long glass rod is fitted; the cork should extend to *a b*, so as to exclude air. This contrivance is entirely filled with mercury, and next freed from any adhering air and moisture by heating over a spirit flame; one of the open tubes at *h* and *g* is in connection with a gas supply-pipe fitted with a tap, the other open glass tube with a burner, while the openings at *d* and *e* are so small that the gas which may pass through them is too small in quantity to heat the bath to any extent, whilst, at the same time, these openings serve to prevent the sudden extinguishing of the flame by the rapid expansion of the mercury.

The apparatus is used in the following manner:—

The bath is heated by a gas burner, until the thermometer connected with the bath indicates nearly the requisite temperature; this having been reached, the glass rod, *f*, is pressed down into the mercury contained in the wider tube, until the mercury at *a* nearly touches the part *c*, which should be made as straight (not rounded) as possible. The sensitiveness of this contrivance depends, of course, upon the quantity of the mercury and its adjustment of surface; but if the apparatus is made with care, according to the directions just described, the bath remains to a fraction of a degree at a constant temperature, even in a draught of air or with a change of pressure of gas. The cooling of the mercury in the narrow tubes prevents oxidation of the metal anywhere in the tube.

The following advantages are obtained by the use of the filtering bulb:—

1. The decantation of liquids is avoided.

2. The washing, ignition, and calculation of the filter-ash is entirely dispensed with. For, since the quantity of ash contained in a filter made of the best paper, and of 12 c.m. diameter, amounts to 0·0005 grm., the ash contained in a disc of filtering-paper, as used with this apparatus, would only weigh 0·00002 grm., and even if the paper were of a commoner quality it would make no difference.

3. The velocity of filtration is very great; the water flowing into the beaker in so uninterrupted a current that it appears as if no paper disc were present. When precipitates are to be filtered off, the velocity is somewhat less;

but it is then far more rapid than by the ordinary plan, and not less rapid than by Bunsen's method.

4. Since the filtering-tube dips under the fluid, no air can pass through the precipitate until it has been completely washed.

5. When a mineral has been dissolved, or when two substances have to be separated from each other, instead of, as is done by the ordinary method, placing them in a beaker to be further treated, the precipitate by this method remains in the crucible, and can be ignited directly after filtration.

6. This apparatus serves as a filtering-stand, and also as a syphon and pipette.

7. The whole apparatus may be readily kept from dust, and, if required, any gas can be readily admitted to protect a fluid to be filtered from contact with air, while a boiling solution can also be readily filtered.

8. Even so small a quantity of substance as a couple of milligrammes is sufficient for analysis. With so small quantities the entire precipitate remains fixed to the filtering disc, and may be burnt on the lid of a crucible, while any other very small portion of the substance which may adhere to any part of the apparatus may be readily removed and estimated.

9. The use of this apparatus, and the employment of small quantities of substance for analysis, occupy only about one-third of the time as compared with that required for analyses done by the ordinary plan. As an instance of the advantage of employing this method of analysis, the author quotes the following:—

A mixture was taken of magnesia, chloride of potassium, and common salt, adding thereto some hydrochloric acid so as to convert the magnesia into chloride, expelling any excess of that acid by a gentle heat. The dry saline mass was re-dissolved in water, and oxide of mercury added. The mass was next gently heated in a covered crucible, until all the mercury was volatilised, and the dry residue again treated with water and filtered by means of the filtering-tube above described, by which operation the magnesia was left behind in the crucible. It was then dried in the air-bath and ignited. The solution of the alkalies was next treated in the usual manner with chloride of platinum and alcohol, and the platino-chloride of potassium, after having been separated from the fluid by the filtering-tube, dried at 105°. The small filtering-paper disc, to which hardly a particle of the salt adhered, was removed, and the platino-chloride of potassium, first ignited by itself alone, and afterwards with the addition of the paper disc; the result being that the organic matter of the paper was sufficiently large to cause the reduction of the platinum to the metallic state. The materials left in the crucible were washed with hydrochloric acid to remove any trace of magnesia, and again ignited; the platinum in the filtrate was also reduced to metal, and the chloride of sodium present determined in the usual way, care being taken to remove and estimate the very small quantity of magnesia by means of phosphate of sodium, and to deduct the weight of the magnesia thus estimated from the weight of the chloride of sodium.

The results were as follows:—

	Quantities taken.	Quantities found.
MgO	0·0690 grm.	0·0688 grm.
KCl	0·1873 ,,	0·1852 ,,
NaCl	0·0876 ,,	0·0900 ,,
	0·3439	0·3440

It appears that the chloride of magnesium was completely converted into magnesia again, notwithstanding the small loss of this substance due to the solubility of some of it in the alkalies present; that the quantity of the potassium salt found was deficient is accounted for by the fact that the salt was only washed with dilute alcohol, without any addition of ether to lessen the solubility of the platino-chloride of potassium. The author analysed twice a portion of a mineral, skolēzite, from Scotland, taking in the first case 0·985 grm. of substance, and in the other 0·0807 grm., the result being that the percentage composition of the substance was found to be:—

	I.	II.
Silica	46·20	46·35
Alumina	26·28	26·21
Lime	9·22	9·17
Soda	5·16	5·10
Water	13·25	13·45
	130·11	100·28

In reference to the difference of the quantity of water, the author observes that the substance had been kept for several months under a desiccator. It is clear that the principle of the apparatus above described may be applied to qualitative analysis, and also in technology on a larger scale, for which purpose a porcelain plate perforated with small holes may be used with a disc of filtering-paper.

CORRESPONDENCE.

WATERING THE STREETS WITH SALINE SOLUTIONS.

To the Editor of the Chemical News.

Sir,—On page 968 of the *Journal of the Chemical Society* for October there occurs the following, taken from *Dingler's Polytechnical Journal*. I will quote the entire abstract:—

"In Hamburg a road-space of 1500 square metres was watered with 5000 lbs. of water, holding in solution 250 lbs. chloride of calcium and 250 lbs. common salt. The surface was well wetted all over. A strong smell of ink was developed, and the road did not remain moist for a perceptibly longer time than when sprinkled with pure water, nor was the formation of a crust to be observed. As the application of a sufficient quantity of salt to a large surface would be costly, and as it would require to be renewed after every heavy rain, it does not appear that the process would be of much value, even if it fulfilled the purpose intended, of absorbing water enough from the air to keep the dust laid.—C. H. G."

I am not aware that any chemist has ever disputed that strong saline solutions do not evaporate so rapidly as common water, or that a very strong solution of chloride of calcium absolutely refuses to dry up at the ordinary temperature of the atmosphere. Most chemists are, indeed, in the habit of observing how, for instance, the lump of chloride of calcium exposed in the balance-case does not become drier but wetter, and, bye and bye, liquefies in the water it absorbs from the atmosphere. The above-recorded observation, viz., that a solution containing 10 per cent of mixed chlorides of calcium and sodium dried up as rapidly as water is obviously false; and it appears rather strange that so sensible a man as Mr. Gill, who made the abstract, and who was for a long time Professor Williamson's assistant, did not append a note to it.

The untrustworthiness of many of these so-called practical facts is notorious, and is occasionally very curiously exemplified.

In the course of last summer a surveyor in one of the London districts observed that the addition of deliquescent salts *accelerated* the drying up of the water!

I wish to place on record in your columns the results of long-continued practice in Westminster—not, indeed, with the object of proving that solutions of deliquescent salts evaporate slower than water, but that the skilful application of deliquescent salts to streets is economical.

The facts are in brief these. In the summer of 1870 and 1871, the Westminster district was watered with a solution of Mr. Cooper's salts, and in both seasons the saving in expense was sufficient to pay for the salts, and to leave a considerable profit to the patentee and to the vestry. Before the salts were used, twenty-two water carts were required to water Westminister; now eleven carts do the work, and the streets of Westminster are in a better condition than before.—I am, &c.,

J. Alfred Wanklyn.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, October 9, 1871.

The only paper met with in this number bearing upon chemistry is:—

Water of the Artesian Well at Rochefort, Charente Inférieure.—Dr. Roux.—This paper contains a detailed account of several geological matters observed by the boring of the deepest Artesian well in existence, viz., 856·78 metres, while those of Grenelle and Passy (Paris) do not quite reach 700 metres. Among the notable observations recorded in this paper we notice the curious fact that the bore-rods used in this work (commenced in 1831 and finished on September 20, 1866) became highly magnetic. The well yields about 3 litres of water per second of time; the water on first reaching the surface is clear, but becomes turbid on standing, owing to loss of free carbonic acid and hence precipitation of earthy salts. The average temperature of this water is 40°6°; its sp. gr. = 1·0053; 1 litre contains:—Nitrogen (reduced to 0° and 760 m.m.), 17·11 c.c.; free carbonic acid (reduced as N), 2·54 c.c.; weight of these two gases together, 0·00504 grms.; free sulphuretted hydrogen, 0·00067 grms.; sulphate of soda, 2·55005; sulphate of lime, 1·80956; sulphate of magnesia, 0·46560; chloride of sodium, 0·77894; chloride of magnesium, 0·03155; chloride of ammonium, 0·00968; bromide of sodium, 0·00392; iodide of sodium, 0·00113; bicarbonate of lime, 0·11057; bicarbonate of magnesia, 0·02699; bicarbonate of protoxide of iron, 0·05066; bicarbonate of protoxide of manganese, 0·00015; arseniate of protoxide of iron, 0·00067; silicate of potassa, 0·00421; silicate of alumina, 0·00720; traces of silicate of lithia, of phosphate of protoxide of iron, and of copper; organic matter (akin to crenic and apocrenic acids), 0·00067; combined water, 0·10200; chloride of calcium, 0·01720; loss, 0·01000; total, 5·98606 grms.

Bulletin Mensuel de la Société Chimique de Paris, January, February, and March (one number), 1871.

Although this small volume is published, as indicated on the title-page, for the months above named, it contains the *extraits* from the *procès verbaux* of the meetings of this society held in June, July, and August last, from which we quote the following particulars:—

Contribution to the History of the Saccharine Substances.—Dr. Maumené.—The author states that large and well-defined crystals of the combination of sugar and chloride of sodium may be obtained by first evaporating on a water-bath a syrup which, upon 100 parts of sugar, contains 13 parts of common salt. The crystalline mass is then put into a funnel, and the mother-liquor several times poured back on the solid substance; by this operation there will be obtained in the filtrate large-sized prismatic crystals, the composition of which is $C_{24}H_{22}O_{22}NaCl+4HO$. The rotatory power of the sugar thus combined is not altered, and by treating the compound with nitrate of silver the sugar is regenerated.

Influence of the Variation of Temperature upon the Mode of Decomposition of Explosive Compounds.—Dr. Jungfleisch.—Alluding to Professor Abel's explanation respecting some of the phenomena of the explosion of detonating compounds, the author states that from his experiments on this subject he is inclined to infer that the phenomena are due to the degree of temperature to which the substances are submitted. This opinion is also shared by Drs. Berthelot and Maumené, who brought the following instances in support of their views:—When nitrate of ammonia is suddenly heated it yields, in addition to water and protoxide of nitrogen, also binoxide of nitrogen and nitrous acid; while, when upon nitrate of potassa kept fused at 337° a piece of the charcoal is placed, it remains black, deutoxide of nitrogen being evolved; but a slight increase of temperature produces a sudden decomposition attended with deflagration.

Polariscopic Rotatory Power of the Alcohols of the Amylic Series.—Dr. Ribau.—A tabulated form exhibiting the amount of rotatory power expressed in degrees of arc of the liquids alluded to.

Experiments Made with the View to Ascertain whether the Two Chlorinated Propylens Derived from the Methyl Chloracetol and the Chloride of Propylen are Identical.—Drs. Friedel and Silva.—As regards the main point, the authors conclude that identity exists; they incidentally observe that the action of chlorine upon propylen is considerably modified by the action of direct sunlight, since in diffused light or complete obscurity a substitution product is formed, viz., a compound, $C_3H_4Cl_2$, boiling at 92° and absorbing bromine with great avidity, forming a chlorobromide, $C_3H_4Cl_2Br_2$, boiling at 205°; in direct sunlight, chlorine is simply fixed without evolution of hydrochloric acid and formation of terchloride, $C_3H_4Cl_2$, boiling at from 122° to 124°; the chlorinated propylen derived from the chloride of proplen is similarly acted upon.

Relation Existing between Tannic and Gallic Acids.—Dr. H. Schiff.—Tannic acid is digallic acid according to the author, the gallic acid yielding by oxidation ellagic acid and another substance endowed with all the properties of tannin. This substance is termed digallic acid, $C_{14}H_{10}O_9=2C_7H_6O_5-H_2O$; by the action of sulphuric acid the digallic acid is converted into rufigallic acid, which on being distilled with zinc-dust yields anthracen.

The original papers and memoirs published in this number, having been also published in other periodicals which we received at an earlier date, have been already referred to.

Les Mondes, October 19, 1871.

This number opens with the announcement of an honour conferred upon the excellent editor, who has received from the Pope the honorary degree of Doctor of Theology, a very high distinction indeed, and the more so as the Apostolic brief (of which the Latin text and a French translation are reproduced in full) intimates that this honour is conferred on Monsieur l'Abbé F. Moigno on account of his scientific labours.

Among the original papers contained in this number we notice the following:—

Unity of Matter.—Dr. Lamy.—The first instalment of a series of papers on chemical philosophy; this portion treats on the formula of acetic acid.

Use of Felspar as Manure.—Rev. Mouzot.—This paper gives a short account of the results obtained by the use of felspar where that mineral abounds and is physically so constituted as to be readily disintegrated, even when being crushed or pulverised previous to being applied to the soil. The felspar contains, as is well known, potassa, and may therefore be useful to the soil, but, as herein stated, the effect upon the vegetation is slow, and the quantity of this mineral to be used per acre rather large.

Obituary.—Under this heading we regret, in the first place, to have to record the death of Dr. Barreswil, well and deservedly known both as an excellent scientific chemist and one of the most eminent technologists of France, the author of the well-known titration process of sugar testing, and, as we learn from the brief notice, also a sound and active philanthropist. Another well-known person, whose death, at the age of 55 years, is here announced is the eminent sugar-refiner, Constant Say, the nephew of the celebrated economist, J. B. Say, and the cousin of the present Préfet de la Seine. The large sugar-refinery founded by the deceased is capable of working 280,000,000 kilos. (280,000 tons) of sugar annually; during the late siege of Paris, that place was supplied by the water from the Artesian well bored at this refinery, the yield of water of that well surpassing that of any known well of the kind. France loses in M. Say one of its most eminent industrial men, and one also who with his immense wealth did a very great deal of good.

Polytechnisches Journal von Dingler, second number for September, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

On a New Steam-Gauge.—Dr. C. V. Zenger.—After pointing out the defects of the different gauges now in use for ascertaining the pressure of steam in boilers, the author describes at great length and illustrates with engravings an instrument which, while simple in its construction, is undoubtedly free from the defects alluded to and inherent to the gauges in general use; moreover, this instrument may be arranged for vacuum guage and for measuring the force of wind.

Continuation of the Studies on the Blast-Furnace and Iron Manufacture.—C. Schinz.—This portion contains the following sections:—Ferrie's auto-coking furnace at the Monkland iron-works; pressure of the blast; what quantity of air is really required. To be continued.

Areometrical Analysis of Beer.—A. Metz.—The description illustrated by a series of algebraical formulæ, of a process of determining in beer—after having been as much as possible deprived of the carbonic acid it contains—by means of a very sensitive areometer, the quantity of extract and alcohol it contains.

General Exhibition at Vienna, 1873.—Dr. von Schwarz-Senborn.—From this paper we quote the following particulars respecting the size, in square metres, of the following Exhibition buildings:—London

(1851), 81,591; Paris (1855), 103,156; London (1862), 186,125; Paris (1867), 441,750; intended building at Vienna, now in course of construction, 2,330,631; the length of the main building will be 950 metres, more than half an English mile.

Bayerisches Industrie und Gewerbe Blatt, July, 1871.

Among the official communications published in this number we briefly notice the following:—

Establishment of a Course of Lectures on Statistics at the Royal Bavarian Ministerial Department of Commerce and Public Works.

Police Regulations on Steam-Boilers for Germany.

Petition Addressed to the German Imperial Parliament for the Introduction of a General Patent Law for Germany.

This number further contains the following original matter relating to chemistry and collateral sciences:—

Description of a Washing Apparatus.—M. Neubecker.—The apparatus herein described and illustrated with engravings appears to possess decided advantages over those in general use.

Method of Coating Metallic Objects with a Very Durable Black-Brown Varnish.—C. Puscher.—On the bottom of a cylindrical cast-iron vessel, 18 inches high, is placed a layer, ½ inch thick, of coal-dust; upon this is placed an iron grating, and thereon are put the iron, steel, or other metallic objects intended to be coated with the varnish. The vessel, having been first closed with a well-fitting lid, is next placed on a bright coke fire, and heated for about a quarter of an hour just to incipient red heat. The vessel is then removed from the fire, and on the lid being removed, after about ten minutes, the metallic objects will be found coated very uniformly with a good and durable varnish, which resists bending, as well as a high temperature, without cracking or coming off. Very small objects, such as hooks-and-eyes for instance, are better placed along with some coal-dust in a coffee-roasting apparatus, and this turned, as is usual in the roasting of coffee, until the metallic objects have obtained the desired depth of colour and are uniformly coated with the varnish.

La Revue des Scientifique de la France et de l'Etranger, October 7, 14, and 21, 1871.

These numbers do not contain any original papers relating to chemistry and allied sciences.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 14, 1871.

This number contains on the title-page a polite request of the Treasurer of this Society, reminding members who have hitherto forgotten to pay their contributions to do so without delay. For the members resident in the United Kingdom, Messrs. Hopkin and Williams, 5, New Cavendish Street, London, W., are the parties to whom payment can be made; the Treasurer at Berlin is Dr. E. Schering, 21, Chaussestrasse.

The original papers contained in this number are the following:—

Calculation of the Heat Evolved by Decomposition.—A. Naumann.

On Melolonthin, a New Crystalline Nitrogen- and Sulphur-Containing Material met with in the Animal Organism.—P. Schreiner.—The substance just named has been found, along with leucin, sarkin, traces of xanthin, large quantity of urates and of oxalate of lime, in the body of the *Melolontha vulgaris*, cockchafer. The insects having been crushed and exhausted with water, this liquid is first boiled, in order to eliminate albumen compounds; after filtration, the previously somewhat evaporated and thereby concentrated liquid is precipitated with acetate of lead, again filtered, and the filtrate treated with sulphuretted hydrogen. The sulphuret of lead having been removed by filtration, the filtrate is again evaporated, so as to allow of the urates being precipitated. After having been further concentrated, the author observed, first separate crystals of leucin, and then another body, which, having been purified by re-crystallisation from its aqueous solution, was obtained in well-defined hard glossy crystals, difficultly soluble in cold, more readily so in hot water, also difficultly soluble in ordinary alcohol, and quite insoluble in absolute alcohol and ether, but readily soluble in some of the caustic and carbonated alkalies, in sulphuric, nitric, hydrochloric, and tartaric acids, and also in water containing a small quantity of ammonia; acetic acid dissolves this substance difficultly. The aqueous solution of melolonthin does not affect vegetable colours; when a solution of melolonthin is boiled along with a solution of oxide of lead in caustic potassa, sulphuret of lead is formed. The elementary composition of melolonthin is $C_8H_{16}N_2SO_2$. From 30 lbs. of the insects the author only obtained 1·56 grms. of melolonthin.

On a New Phosphorus Oxychloride, the Pyrophosphoric Acid Chloride.—A. Geuther and A. Michaelis.—After observing that of the chlorides of phosphoric acid only that of the ordinary phosphoric acid, $POCl_3$, is known, while the chlorides of the meta-phosphoric acid, PO_2Cl, and that of the pyrophosphoric acid, $P_2O_2Cl_4$, are, or as far as the latter is now concerned were, unknown, the authors proceed to describe at length the method by which they succeeded in preparing the last-named compound. The preparation, which requires some caution, consists mainly in treating terchloride of phosphorus with nitrous acid. The product resulting from that reaction is rectified by distillation at from 210° to 215°, yielding a colourless fluid which cannot be distilled without partial decomposition; the vapours of this body are akin to those of anhydrous sulphuric acid, and destroy corks; sp. gr. of the liquid, viz., $P_2O_2Cl_4$, at 7° = 1·58. Addition of water to this body decomposes it at once, heat being evolved and hydrochloric acid and ordinary phosphoric acid; the rational formula of this phosphorus oxychloride is—

$$\begin{matrix} {}^{V}O \\ PO \\ Cl_2 \end{matrix} \text{---} \begin{matrix} {}^{V}O \\ P \\ Cl_2 \end{matrix} \quad \text{or} \quad POCl_2\text{---}O\text{---}POCl_2.$$

Capability of Crystallisation (Krystallisations Fähigkeit) of the Ordinary Oxychloride of Phosphorus and of the Oxybromochloride of Phosphorus.—A. Geuther and A. Michaelis.—The authors have found that the ordinary oxychloride of phosphorus when cooled to −10° remains fluid, but solidifies at once when touched with a glass rod, yielding long-sized needle-shaped crystals, which melt at −1·5°. The oxybromochloride of phosphorus when cooled down below 0° also yields crystals, which melt again at +11°.

Detection of Phenol and Bodies related thereto by means of Bromine-Water.—H. Landolt.—While engaged in testing a well-water contaminated with gas-liquor (ammoniacal water of a coal-gas work), it occurred to the author to try to detect phenol in the well-water. After having vainly tried some of the more ordinary reagents of phenol, bromine-water was employed, and observed to yield, when added in excess to a portion of the well-water, at once a yellowish-white coloured precipitate of tribromphenol, which, being insoluble, is a very characteristic, and, as found by expressly-made experiments with pure phenol, renders 1 part of that substance distinctly discernible in 437,000 parts of water. 1 part of phenol in 571,000 parts of water does not yield immediately a precipitate upon the addition of bromine-water, but after standing some time a crystalline substance, tribromphenol, makes its appearance. Phenol may be detected by the peculiar odour it has when 1 part of that body is present in 2800 parts of water. The author states that bromine-water may be used for the quantitative estimation of phenol, by collecting the precipitate of tribromphenol upon a previously-weighed filter, and drying it over sulphuric acid. The molecular weight of tribromphenol, $C_6H_3Br_3O$, is 331. In order to test whether a precipitate obtained by bromine-water is due to phenol, collect the sediment upon a filter, wash it with water, and then place the precipitate along with sodium amalgam and some water in a test-tube; after the application of a gentle heat the fluid is poured into a small evaporating basin, and sulphuric acid added, whereby the characteristic odour of phenol is emitted, and small drops of that substance may be seen floating in the fluid. As the best means to test any well-water suspected to contain traces of gas-liquor, the author advises that a larger quantity of the water should be first acidulated with sulphuric acid, then submitted to distillation, and the first quantity collected in the well-cooled receiver should be treated with bromine-water. The remainder of this very exhaustive paper is devoted to the description of the reactions which many substances, such as, for instance, aniline, toluidine, quinine, &c., yield with bromine-water.

Difference of Energy (Energie Differenz) Displayed by Phosphate af Soda Containing a Different Quantity of Water of Crystallisation.—L. Pfaundler.—Notwithstanding the high scientific value of this paper, treating on a subject bearing upon the mechanical theory of caloric, its contents are not suited for useful abstraction.

On Sulphobromide of Phosphorus.—A. Michaelis.—The substance referred to (discovered by Baudrimont and described by him in the *Comptes Rendus*, i., pp. 111, 517) has been studied anew by the author, who states that it crystallises in octahedra, gives off an aromatic but very pungent smell, fuses at 35°, is readily soluble in ether, sulphide of carbon, and bromide of phosphorus, and is not so readily decomposed by water as might be expected. The products of this decomposition are sulphuretted hydrogen, sulphur, phosphoric and phosphorous acids. In contact with ammonia, the sulphobromide of phosphorus is slowly decomposed in the cold, more rapidly when heat is applied; the products of this decomposition are the same as those formed by the action of water. When sulphobromide of phosphorus is prepared, according to Baudrimont's process, by the reaction of sulphuretted hydrogen upon superbromide of phosphorus, the product should be first heated with water for eliminating non-decomposed superbromide, next the substance is placed between folds of blotting-paper, and then dissolved in sulphide of carbon; the adhering water having been withdrawn by fused chloride of calcium, the sulphide of carbon leaves after its evaporation the sulphobromide of phosphorus in crystalline state.

Note on Artificial Alizarine.—R. Bœttger and T. Petersen.—This paper is illustrated with a spectrum absolutely required for the due understanding of the contents.

Tension of Dissociation of Carbaminate of Ammonia.—A. Naumann.—The contents of this lengthy and highly valuable essay, elucidated by several tabulated forms, are not suited for abstraction.

Behaviour of some of the Diazo-Compounds with Alkaline Sulphites.—A. Strecker.—The following compounds are mentioned in this essay:—Combination of diazo-benzol with sulphite of potassa (formula of the salt dried at 120°, $C_6H_7N_2SO_3K$), contains 7·4 per cent of water of crystallisation driven off at 120°; the salt is insoluble in alcohol, and very difficultly so in water; when heated with soda-lime, neither N nor aniline are evolved. Diazo-benzol-sulpho acid, forms when acted upon by sulphite of potassa a solid crystalline mass, readily soluble in boiling water, slightly soluble in alcohol; solutions exhibit acid reaction to test-paper; formula of the compound, $C_6H_5N_2SO_3$. This paper also contains some theoretical views on the constitutional formula of the diazo-compounds, illustrated by a series of complicated formulæ.

On Fore-Run.—G. Krämer and A. Pinner.—This essay is mainly written in defence of the papers published by the authors on this matter (relating to the by-products of the distillation of spirits) against the views held on this subject by Dr. Kekulé.

Chemistry at the Forty-Fourth Meeting of German Natural Philosophers and Physicists at Rostock (Mecklenburg-Schwerin), September, 1871.—V. Meyer.—This extensive paper contains a report of the proceedings of the Chemical Section of this association, which section was presided over by Dr. Schulze, Professor of Chemistry at the celebrated and ancient University of Rostock (a town of some 30,000 inhabitants). The savant just named exhibited the formation, by direct oxidation of carbon (pure), of an acid which has been provisionally named anthraconic acid, but which in many of its reactions and combinations appears to be, if not quite identical with, at least akin to mellithic acid. Owing to the importance of this subject, the author, assisted by Drs. Carstanjen and Baeyer, performed at a later meeting a series of experiments which leave no doubt whatever that pure carbon may be made to yield by its oxidation mellithic acid, which, on being distilled along with soda-lime, gave benzol, and this, having been nitrated, yielded after reduction aniline. Mellithic acid occurs now and then native in brown-coal deposits. The same author describes a modification of Schlösing's method of the estimation of nitrates in potable water, which consists in the use of a peculiarly constructed flask wherein the water to be tested, after previous concentration on a water-bath, is first boiled, and a partial vacuum having been produced, a mixture of hydrochloric acid and perchloride of iron is introduced into the flask, whereby, if nitrates are present, deutoxide of nitrogen is formed, which is collected in a graduated tube made on purpose for this use by M. Giessler, at Bonn. The small quantity of air carried over with this gas is, before measuring its bulk, absorbed by a solution of protochloride of iron. It is not practicable to enter here into further details on the subjects which were *viva voce* and briefly treated of at this meeting, and are here only cursorily mentioned. The speakers all intend to publish their researches in this or other periodicals.

La France Scientifique (*Ancien Cosmos*), October 8, 1871.

In addition to subject-matter more particularly bearing upon and of interest to France, this number contains an excellent original paper:—

On Comparative Geology.—Dr. S. Meunier.

October 15, 1871.

This number does not contain any original papers or memoirs relating to chemistry or collateral sciences.

October 22, 1871.

The only original paper more strictly relating to exact sciences published in this number is:—

Social Philosophy of Sciences.—Dr. V. Meunier.

NOTES AND QUERIES.

Lute.—Can any of your readers acquaint me with a cheap and effective lute for wood retorts? It would have to resist the vapour of crude wood or acetic acid.—W. S.

Purifying Coal-Gas.—Can any of your readers give me the best way, on a small scale, of freeing coal-gas from impurities for laboratory use, or when heating, not illuminating, power is necessary?—M. H.

MEETINGS FOR THE WEEK,

Monday, Nov. 6th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "Elementary Physiology (II.)."

—— Royal Institution, 2. General Monthly Meeting.

TO CORRESPONDENTS.

A. E. Reed.—Your letter has been handed to the writer of the article. Professor Abel's address is Woolwich Arsenal.

Alpha.—Apply to Kuhlmann and Co., Lille, France, for commercial information on all compounds of baryta.

E. R.—Cooley's "Cyclopœdia of Practical Receipts."

J. Hirgin.—Schützenberger's "Traité des Matières Colorantes Comprenant leurs Application à la Teinture," &c. 2 vols; Paris: Victor Masson. The Editor's work on the subject is in the press.

J. M. Merrich.—The paper was published in our issue of October 13, No. 620.

Dr. W. M. Watts, Marshall Hall, J. E. Wright, R. Routledge, T. Fletcher.—Received with thanks.

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The Session 1871—1872 will commence on the 2nd of October, when the Laboratories will re-open at 10 a.m. for Instruction in Practical Chemistry as applied to Pharmacy, Medicine, Analysis, &c. Pupils can enter at any period. Terms moderate.

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The LATIN CLASS for the reading of Physicians' Prescriptions, Cæsar's Commentaries, &c., every Tuesday and Friday evening, commencing October 3rd, at 8 p.m.

The BOTANICAL and MATERIA MEDICA CLASS, every Wednesday and Saturday evening, commencing October 4th, at 8 p.m. The usual EXCURSIONS for the STUDY of PRACTICAL BOTANY will be continued every Saturday, until further notice, at 10 a.m.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 624.

NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

II.

CASEIN is a variety of albumen contained in milk, not coagulable by heat, but readily with acids. To obtain it, evaporate milk to dryness, digest with ether to remove fat, dissolve in water, and precipitate with alcohol.

It is supposed that the solubility of casein is due to free alkali, and its spontaneous coagulation to the neutralisation of this with lactic acid generated by decomposition; it is not known how rennet acts when coagulating milk.

$MgSO_4$ + milk + heat, produces a pasty mass. Human milk contains about 3·0 per cent of casein; the ash of casein varies considerably. Mulder, 3·8 per cent; F. Simon, 7·0 per cent.

Cheese is impure casein, milk curdled by rennet, and pressed; flavour of cheese dependent on decomposition, the products being NH_3, valerianic and butyric acids; old cheese is thus the most highly flavoured.

Cheese + CaH_2O_2 produces a tenacious paste.

Gelatinous Substances.

These substances do not exist in the body, but are formed by the action of boiling water. The tissues from which they are obtained are identical in composition with gelatin. Gelatin and its allies are derivatives of albumen, and are not to be obtained from any but structures serving a mechanical purpose; structures, as muscle, which are converted into force yield albumen (fibrin). Gelatin not existing in actively vital tissues does not minister to the support of the animal economy; this is proved to be correct by experiments on dogs, &c.

Gelatin is insoluble in cold water, freely soluble in hot; a solution containing 1 per cent solidifies on cooling.

Isinglass, glue, and size are modifications of gelatin. It is precipitated from solution by alcohol, HgCl, and tannin. Chlorine gas precipitates gelatin freely.

Ca_32PO_4 is readily dissolved and taken up by gelatin; this is admirably exemplified in bone.

H_2SO_4 dissolves gelatinous bodies, and converts them into glycocin (glycocoll) and leucin. KHO also produces leucin amongst other things during decomposition.

Chondrin contains less oxygen than gelatin, and differs on being precipitated by $C_2H_4O_2$, alum, and plumbic acetate.

By oxidation converted to gelatin, it is found in the permanent cartilages, also in fœtal cartilage before ossification has commenced.

So-called Bases of Animal Origin.

These are mostly the result of the disintegration of force-producing tissues. They all contain N in large quantities, and are found mostly in the excreta.

Urea (CH_4N_2O); colourless, crystallises in prisms, deliquescent; contains more N than any other definite compound; it seems to be the means of carrying most of the waste N out of the system.

It occurs most abundantly in the urine; it is excreted from the blood by the urine to the extent of 1½ ozs. daily. The urine of carnivora contains it more largely than that of other animals.

Urea is metameric with NH_4CNO; and may be formed from it by evaporating a solution to dryness over a water-bath.

Heated to 120° C. urea melts; at a somewhat higher temperature decomposes; NH_3 and cyanate and carbonate of ammonium being formed, cyanuric acid is left in the retort; the temperature being raised, melanuric acid is formed, and this, at a still higher temperature, is converted to mellon (C_9N_{13}), familiar to us as the yellow coating of Pharaoh's serpents. Biuret is obtained by heating urea at 170° C.; this body is very stable, it may be dissolved in concentrated mineral acids without decomposition.

Urea combines both with acids and bases; in one case forming such bodies as nitrate of urea, and in the other such as its mercuric salt ($2CH_4N_2O,3HgO$). Some remarkable and interesting bodies known as compound ureas are formed by substitution of various radicles for H.

Kreatin and kreatinin are compounds similar to urea; they are found in urine, the juice of muscle, &c. Kreatin, $C_4H_9N_3O_2,H_2O$, about 5 grs. in 1 lb. of flesh; cod-fish contains more than other flesh.

Kreatinin, $C_4H_7N_3O$, occurs with kreatin, but may be formed by boiling the latter substance with HCl. Sarkosin and guanin are similar but unimportant bodies.

There are three bodies which are closely allied in properties forming homologous acids when acted on by nitrous acid; these are glycocin, alanin, and leucin. Glycocin, or glycocoll, the result of boiling gelatin in H_2SO_4, gives glycolic acid. Alanin gives lactic acid.

Leucin (obtained by fusing cheese with KHO, dissolving in hot water, supersaturating with $C_2H_4O_2$, filtering, evaporating mother-liquor, and crystallising) gives leucic acid.

Glycocin,	$C_2H_5NO_2$	Glycolic,	$HC_2H_3O_3$.
Alanin,	$C_3H_7NO_2$	Lactic,	$HC_3H_5O_3$.
Leucin,	$C_6H_{13}NO_2$	Leucic,	$HC_6H_{11}O_3$.

NOTE ON THE CHROMIUM OXYCHLORIDE DESCRIBED BY HERR ZETTNOW

IN

"POGGENDORFF'S ANNALEN DER PHYSIK UND CHEMIE," No. 6, 1871.

By T. E. THORPE, F.R.S.E.

IN the above-mentioned number of *Poggendorff's Annalen*,* Herr Emil Zettnow describes an oxychloride of chromium to which he assigns the formula $Cr_2Cl_4O+4CrO_3$. It is obtained by heating potassium chlorochromate—

$$K_2Cr_2O_6Cl_2$$

with strong sulphuric acid, and after a somewhat tedious course of preparation appears as a brownish black, brittle, amorphous substance, exceedingly hygroscopic, and giving up its chlorine with great ease. Herr Zettnow's analytical results and the numbers required by his formula are—

	Found.	Calculated.
Cr	47·28	47·23
Cl	22·31	21.42
O	—	31·35
		100·00

In the *Proceedings of the Literary and Philosophical Society of Manchester* for November 2, 1869† I described a solid chromium oxychloride obtained by simply heating chromyl dichloride in a sealed tube, and which, on completely freeing from the latter body, "appears as a black non-crystalline powder, which, when exposed to the air, rapidly deliquesces to a dark reddish-brown syrupy liquid which smells of free chlorine (*loc. cit.*). These properties,

* See also CHEMICAL NEWS, vol. xxiv., p. 133.

† CHEMICAL NEWS, vol. xx., p. 245. *Zeitschr. für Chemie*, Jan. 1870, p. 95.

it will be observed, are precisely those which Herr Zettnow describes as belonging to his chromate of chrom-oxychloride. On analysis it yielded as the mean of four determinations made on different preparations:—

Cl	21·06
Cr	48·91

numbers approximating to those obtained by Herr Zettnow. To this compound I was induced, for reasons which I need not here reproduce, to give the formula—

$$ClCrO_2.O.Cr''O.CrO_2Cl,$$

and to regard it as the chromium term of a series of salts a few members of which had already been described by Peligot, viz.:—

Potassium chlorochromate		$ClCrO_2.O.K_2.O.CrO_2Cl$
Sodium	,,	$ClCrO_2.O.Na_2.O.CrO_2Cl$
Ammonium	,,	$ClCrO_2.O.(NH_4)_2.O.CrO_2Cl$
Magnesium	,,	$ClCrO_2.O.Mg.O.CrO_2Cl$
Calcium	,,	$ClCrO_2.O.Ca.O.CrO_2Cl$

The above formula for the chromium chlorochromate requires—

Cl	21·86
Cr	48·54

From the close agreement in the analytical results and correspondence in their physical properties, I am inclined to believe that Herr Zettnow's compound is identical with mine. Potassium chlorochromate heated with sulphuric acid yields, among other products, chromyl dichloride, and, doubtless, Herr Zettnow's compound has been derived from this body under circumstances analogous to those in which I have already operated.

As my little notice on this matter has evidently not come under Herr Zettnow's observation, he may be interested to learn that the six or seven weeks time which he finds necessary to give to the preparation of this rather uninteresting compound may be considerably shortened by simply heating the chromyl dichloride in a closed vessel, when, in a few minutes, it may be transformed in any wished for quantity almost completely into the chromium chlorochromate and free chlorine.

ON THE

ESTIMATION OF SULPHUR BY BARIUM.

By R. GLENDINNING and A. EDGER,
Newcastle-on-Tyne.

OWING to some delay we did not receive the CHEMICAL NEWS of the 13th ult., until a week after its publication, and were thereby late in seeing the remarks of Messrs. Teschemacher and Smith upon our paper on the above subject.

They quote from our article, "We attribute this (film) to sulphate of iron." Now the above quotation taken by itself is calculated to destroy the meaning of our explanation of the cause of the "film" of sulphate of baryta.

To save our readers the trouble of reference, we beg to lay before them the passage to which Messrs. Teschemacher and Smith have taken particular exception:—

"The fact that sulphate of baryta is gradually deposited when the clear filtrate and washings are allowed to stand for some time, will admit of a different explanation than that offered by them, that (sulphate of barytes is noticeably soluble in hot and but moderately diluted hydrochloric acid). We attribute this to sulphate of iron, which is invariably carried down with the sulphate of barytes, and which appears on treatment with hydrochloric acid after the precipitate has been freed from chloride of barium."

The natural inference to be drawn from the above remarks by any one at all familiar with chemical reactions, would be that, on the sulphate of iron in the acid washings coming in contact with the chloride of barium in the filtrate, a precipitation of sulphate of barytes would result.

We did not deem it necessary to take up the valuable space of the CHEMICAL NEWS by entering into such superfluous explanations. The object of our paper was simply to state facts which our long experience in the testing of sulphur ores had brought under our notice, not to excite the animosity of Messrs. Teschemacher and Smith. It is to be regretted that our having ventured to disagree with these gentlemen should have caused them to show their disapproval in such strong terms.

REPORT ON THE

MOLECULAR DISSOCIATION BY HEAT OF COMPOUNDS IN SOLUTION.*

By CHARLES R. C. TICHBORNE, F.C.S., M.R.I.A., &c.

(Concluded from p. 213).

ADDENDUM.

On the Transition of Compounds from the Colloid to the Crystalloid Condition.

IN part I of this report reference has been frequently made to the fact that ferric, chromic, and aluminic oxides and their compounds are capable of taking the colloidal form. It may be necessary to explain what the author means in reference to this point.

Now there is a peculiar character of crystallisation discerned in minerals which is always indicative that the constituents had been previously in this colloidal condition, and had afterwards become crystalloidal. In most cases, this change proceeds from assimilation of water of crystallisation, but not necessarily so. The characteristic which I wish to specify is where the crystals radiate from a centre and form in the aggregate what may be termed the radial spherical system. It includes many of the forms technically known as nodular, mammellated, botryoidal, and reniformed masses. Such minerals are formed in most cases from aqueous solutions, which had evidently been at one period under the dissociating influence of heat. The iron, manganese, and lime minerals, and also the zeolites, exhibit these peculiar forms most strikingly, but none more so than that beautiful mineral wavellite. The mode by which this form of crystallisation is produced cannot be more strikingly exhibited than by an organic salt which I described some years ago, viz., chlorate of quinia. Although this substance is organic the formation can be more easily observed in such a case than in the minerals, where time and pressure are such important elements that it is not capable of experimental verification.

If a very strong and boiling solution of chlorate of quinia be allowed to cool, we find that when the solution arrives at a temperature of about 47° C. the salt begins to fall out, but not in a crystalline form. On examination with a magnifying lens it will be seen that it is separating in globules, which, from the natural laws of fluids floating in fluids, take the shape of perfect spheres. There is generally one large sphere surrounded by a number of small ones which frequently coalesce, showing that they are simply obeying the ordinary laws of gravity of mass. The colloid spheres after some time become crystalline. Thus, starting from the centre, crystals shoot out to the periphery and produce those elegantly arranged masses so well shown in wavellite. Indeed, the salt chlorate of quinia, when viewed in the vessel in which it is crystallised, bears such a wonderful resemblance to that mineral that this salt might be aptly termed organic wavellite. If we make a section of one of the globes of wavellite, we shall generally find that

* Read before the Royal Irish Academy, April 24, 1871.

outside of the general mass is a layer of crystals which are evidently a distinct supplementary formation. This would seem to be a further formation of the mineral after it had ceased to be deposited in the colloid spheres, or, perhaps, the alteration in character of the mineral from a change in the temperature at which the mineral was no longer deposited in its colloidal condition. Two conditions of deposition are likewise observed in the organic salt. This outside layer generally forms but a small proportion to the mass of the sphere in the mineral. The conversion of the compounds of the trioxides into the colloidal state on heating their solutions is rendered probable by their slowness in crystallisation, and from the spherical form of crystallisation so frequently observed in the minerals of this group. Many of their salts also exhibit this phenomenon. Thus, if a solution of hydrated ferric chloride is crystallised by slow evaporation, distinct and well-formed crystals of the salt are produced; but if it is evaporated by heat to a strong solution to such a point that there is a limited amount of available water, it crystallises by re-absorption of atmospheric moisture in the spherical form,* from the radii striking out to what must evidently have been the periphery of colloidal separations.

ON THE ESTIMATION OF ANTIMONY,

AND THE

SEPARATION OF ANTIMONY FROM TIN, FROM ARSENIC, FROM TIN AND ARSENIC, AND FROM THE OTHER METALS, BY MEANS OF A NEW PRECIPITATING REAGENT OF ANTIMONY.

By HUGO TAMM.

(Concluded from p. 209).

Estimation of Antimony in Antimony Regulus.

TWENTY grs. of the metal finely powdered are attacked by hydrochloric acid, to which powdered chlorate of potash is added little by little until all the metal is taken up. Aqua regia might be used instead of the former mixture, but chemists could not be warned too much against using this double acid when the gallic acid process is employed.

In these operations, antimony is of course dissolved in the state of perchloride, which is, even in solution, a very volatile substance.

By reason of a phenomenon not well studied yet, it is only with an extreme difficulty that the nitro-chlorinated fumes evolved by aqua regia can be made to leave perchloride of antimony, with which they appear to form a combination remarkable for its stability. Indeed, it is almost impossible to free perchloride of antimony from these fumes without volatilising part of it.

By using chlorate of potash, on the contrary, the solution of perchloride of antimony obtained can be freed from the chlorine evolved with the utmost facility and at a low temperature. Besides, the chloride of potassium formed during this operation combines with perchloride of antimony, and gives stability to this compound, which can be handled at a much higher temperature than the simple chloride, without incurring the risk of any loss of antimony by volatilisation.

As soon as all the antimony is dissolved, and the last traces of chlorine are disengaged, powdered iodide of potassium is added, little by little, until no more iodine is evolved. If it is necessary, a little excess of hydrochloric acid is added to assist the reaction.

This operation can be conducted with safety at a temperature near that of the boiling-point of the liquor. At that temperature iodine is freely volatilised, and any loss in antimony is completely prevented by the presence of chloride of potassium.

* $Fe_2Cl_6 6H_2O$ (Mohr).

As soon as a slight excess of iodide of potassium dissolves in the clear liquor without deepening its colour or evolving iodine, the reduction of the perchloride of antimony is complete. If the solution is too acid, it is evaporated to the proper degree of concentration, and it is then precipitated by gallic acid.

All the metals alloyed with antimony will be found in the liquor separated by filtration from gallate of antimony, where they can be separated from each other and estimated by the usual methods. Iron forming an exception, it must be estimated in a special operation,—in that in which the alkaline metals which might be alloyed with antimony would be determined.

Estimation of Antimony in Antimonial Fumes, and in Artificial and Native Oxides of Antimony.

The estimation of antimony in native oxides of antimony has become of late an important operation, owing to the discovery of large deposits of this substance, constituting the best ores of antimony known to metallurgists.

The native oxides of antimony, as well as the calcined oxides of antimony, are generally insoluble in hydrochloric acid, and formerly it was necessary to fuse them first with carbonate of potash, or a mixture of carbonate of potash and sulphur in order to dissolve them.

But this operation, one of the most tedious in analysis, has been entirely superseded by the method which I am going to describe, and which answers admirably the purpose.

Iodide of potassium not only reacts on solutions of perchloride of antimony, but, in presence of hydrochloric acid, it reduces both antimonious and antimonic acid to the state of teroxide of antimony soluble in hydrochloric acid, with formation of terchloride of antimony. Iodine is evolved.

This interesting reaction takes place according to the following formulæ:—

$$SbO_4 + 4HCl + KI = SbCl_3 + 4HO + KCl + I.$$
$$SbO_5 + 5HCl + 2KI = SbCl_3 + 5HO + 2KCl + 2I.$$

Consequently to analyse or to assay any of the oxides of antimony, whether artificial or native, they are first of all finely powdered; 20 grs. of the oxides are mixed with hydrochloric acid; the mixture is heated, and iodide of potassium is added until no more iodine is evolved, this being the best indication that all the oxide of antimony is dissolved. The solution is filtered in order to separate it from any insoluble residue, and the filter is washed with dilute hydrochloric acid; this solution is then evaporated to the proper point and precipitated by gallic acid.

The complete analysis may be conducted on 50 grs. in the same way as above, and native oxides will be found in general remarkably free from arsenic and from metals.

Fifty grs. more are dissolved by hydrochloric acid and iodide of potassium, and the solution is precipitated by sulphuretted hydrogen in order to estimate iron and the earthy metals.

When, as frequently happens, the ore to be tried is formed of a mixture of sulphuret of antimony and of oxide of antimony, the ore is dissolved first in hydrochloric acid, the solution is poured off the insoluble residue, which is next dissolved in hydrochloric acid and iodide of potassium. The two solutions mixed together are evaporated and precipitated by gallic acid.

Oxides of antimony, from whatever source they come, being dissolved by hydrochloric acid or by a mixture of hydrochloric acid and iodide of potassium, the estimation of antimony in these compounds has thus become one of the most simple operations in analysis.

Separation of Antimony from most Metals.

Gallic acid effects with the greatest perfection the separation of antimony from most metals, when the

general ways of proceeding and the general precautions as above explained are applied to the analysis of alloys and compounds of antimony. The immense advantage of the gallic acid process is, that by its means antimony is both separated and estimated in one operation, while by the sulphuretted hydrogen process the sulphide of antimony obtained in most cases is of an unknown composition, even when free from other metals, and that it cannot be used for the direct estimation of antimony.

However, sulphuretted hydrogen must remain the standard precipitating reagent of antimony, and its standard separating reagent from all the metals which are not precipitated by sulphuretted hydrogen; and in the analysis of alloys and other compounds of antimony the simultaneous use of both methods ought to be recommended.

By the gallic acid process antimony is separated and estimated in the state of bigallate of antimony, while all the other metals are left in the solution, from which they may all be precipitated (with the exception of iron) either by sulphuretted hydrogen, sulphide of ammonium, or by the successive use of both reagents.

By the sulphuretted hydrogen process, on the contrary, iron which cannot be estimated properly by the gallic acid process, and all the metals not precipitated by sulphuretted hydrogen, remain in solution, so that by the judicious use of these two methods most perfect and elaborate analyses of antimony compounds may be obtained.

It would be tedious, and, on the whole, useless, to describe with more detail the separation of antimony from each metal, but it is, on the contrary, most important to know how the gallic acid method answers for the separation of antimony from the metals which are precipitated with antimony by sulphuretted hydrogen.

Separation of Antimony from Silver, Mercury, Bismuth, Cadmium, Copper, and Lead.

Whenever a clear solution of chlorides can be obtained after the successive use of hydrochloric acid, chlorate of potash, and iodide of potassium, and providing the solution is not too acid, it may be successfully treated by gallic acid, and antimony will then be separated with the greatest perfection from either silver, mercury, bismuth, cadmium, copper, lead, or from a mixture of these metals.

When, on the contrary, the quantity of silver or lead is so great that the compound cannot be dissolved by hydrochloric acid and chlorate of potash, another method must be resorted to, the sulphide of ammonium process being the best.

In alloys or compounds of antimony and copper no better method than the gallic acid process can be used, especially when there is more antimony than copper. The separation is quite perfect. In the liquor separated by filtration from bigallate of antimony, copper may be precipitated in the state of sulphocyanide by means of the copper reagent* and any other metal may be estimated afterwards.

Type metal and other alloys of antimony with lead and other metals can be most successfully analysed by the gallic acid process.

The alloy reduced to a fine state of division is attacked by hydrochloric acid and chlorate of potash; the produce, which at this stage of the operation may not be clear, but milky, is reduced by iodide of potassium; a clear liquid is obtained, which is precipitated by gallic acid. The separation is complete, and in the solution lead may be thoroughly precipitated by sulphuric acid, and afterwards any metal which may be present.

I will not insist further on the analysis of compounds of antimony and silver, mercury, bismuth, cadmium, copper, and lead. From the general statements contained in this paper, it must be quite evident that whenever it is possible to use it all the advantages are in favour of the gallic acid process.

* Chemical News, vol. xxiv., p. 91.

Separation of Antimony from Arsenic.

The separation of antimony from arsenic, which was, until lately, a delicate as well as a difficult separation, has been wonderfully simplified by the application of the gallic acid method to the separation of those two congener substances.

Iodide of potassium, which, in presence of hydrochloric acid, reduces peroxide of antimony to the state of teroxide with evolution of iodine, reacts in a similar manner on arsenic acid, which it reduces to the state of arsenious acid—

$$AsO_5 + 2HCl + 2KI = AsO_3 + 2HO + 2KCl + 2I.$$

So that whenever arsenic and antimony co-exist in an hydrochloric solution, by the addition of a sufficient quantity of iodide of potassium, an hydrochloric solution of terchloride of antimony and of arsenious acid is obtained. Now this is very fortunate, for the separation of antimony from arsenic by gallic acid is especially neat and easy when antimony existing as terchloride, arsenic is present in the state of arsenious acid.

The chief products containing both antimony and arsenic which it is important to analyse are compounds of oxides of antimony with arsenious or arsenic acids, the mixtures of sulphurets of antimony and arsenic obtained in the course of a great number of mineral analyses, and lastly alloys of antimony and arsenic. The mixture of oxides of antimony and arsenic has only to be treated by hydrochloric acid, to which iodide of potassium is added until no iodine is evolved, to give hydrochloric solutions of teroxide of antimony and arsenious acid quite ready to be precipitated by gallic acid. The mixture of sulphurets, or the alloys of antimony and arsenic, after being reduced to a very fine state of division, are attacked by hydrochloric acid and chlorate of potash. The solution is freed from chlorine by heating for a short time at a low temperature, and then reduced by means of a slight excess of iodide of potassium until no more iodine is evolved. If the solution is too acid, it is evaporated until crystals of iodide of antimony begin to appear, and it is then precipitated by gallic acid.

The filtering and washing of the precipitate of bigallate of antimony are conducted exactly as in the previous separations.

Antimony is estimated either as bigallate or as tersulphide, and arsenic is precipitated from the filtrate by means of sulphuretted hydrogen in the state of tersulphide.

When there is more antimony than arsenic in the compound to be analysed, 20 or 25 grs. is a sufficient quantity to operate upon; but when there is a great deal more arsenic than antimony, it is advisable to operate upon 50 grs.

There is no peculiarity to be noticed in the separation of antimony from arsenic by the gallic acid process. The general considerations given above apply here, and with a little care and a little experience very accurate results are obtained.

Separation of Antimony from Tin.

Iodide of potassium has no reducing effect upon hydrochloric acid solutions of perchloride of tin, but when an excess of iodide is introduced in the solution a double decomposition takes place, and the liquor consists of an hydrochloric acid solution of periodide of tin. This reaction is important, as experience has proved that gallic acid separates much more easily teroxide of antimony from biniodide of tin than from the bichloride of the same metal.

The most important compounds containing antimony and tin are the alloys of those two metals, and, in general, 20 or 25 grs. of the alloy previously reduced to a very fine state of division are sufficient to conduct successfully the separation. The alloy is dissolved as usual in a mixture of hydrochloric acid and chlorate of potash.

It is in this instance more especially that the use of

aqua regia should be forbidden; bichloride of tin, like perchloride of antimony, retains powerfully the fumes evolved by aqua regia, and it is not possible to drive off those fumes without volatilising a considerable quantity of tin and antimony.

The solution in hydrochloric acid and chlorate of potash, freed from chlorine as usual, is reduced by iodide of potassium until no more iodine is evolved. When this is done a quantity of iodide of potassium, equal to about half the quantity of iodide employed for the reduction of the liquor, is added in excess, and the mixture is heated for a short time. It is a judicious addition of a sufficient quantity of this salt in excess which decides a successful separation of antimony from tin by gallic acid. After the solution has been brought to the proper degree of concentration, gallic acid is added and afterwards water.

When the former series of operations has been properly conducted, bigallate of antimony settles very rapidly in the liquor. When, on the contrary, the operation has been badly performed, bigallate of antimony is mixed with peroxide of tin, and it remains in suspension in the liquor without settling. In this case the liquor should be rejected as unfit for a neat separation.

When, on the contrary, bigallate of antimony settles rapidly, the operation can be depended upon, and the filtering and washing of the precipitate are proceeded with. Antimony is estimated either as bigallate or as tersulphide, and tin is precipitated from the filtrate by sulphuretted hydrogen in the state of bisulphuret of tin, which, on calcination at a high temperature, gives pure peroxide of tin.

The separation of tin and antimony by gallic acid is not quite so simple as the separation of antimony from arsenic by the same process, for the reason that tin cannot be easily reduced from the state of perchloride to that of protochloride. But if it were possible to effect easily this transformation, the separation of antimony from tin would then be the easiest separation that can be effected by means of gallic acid. However, such as it is, the separation is very neat, and requires only a little attention and experience to be quite perfect.

Separation of Antimony from Arsenic and Tin.

Although gallic acid separates well antimony from arsenic, and antimony from tin, it does not follow that gallic acid should separate properly antimony from arsenic and tin. Still, it is a positive fact gallic acid separates, and separates well, antimony from arsenic and tin. The separation is conducted exactly as a separation of antimony from tin.

The three metals are dissolved by hydrochloric acid and chlorate of potash respectively in the state of perchloride of antimony, arsenic acid, and bichloride of tin. On addition of iodide of potassium until complete evolution of iodine, antimony is reduced to the state of terchloride, arsenic to that of arsenious acid, and, on addition of a proper quantity of iodide in excess, tin is transformed into biniodide of tin.

When the solution thus obtained has been brought to the proper degree of concentration, and properly freed from the excess of hydrochloric acid which it might still contain, it is precipitated by gallic acid, water is added, and the remaining part of the operation is conducted as usual.

The best indication that the separation is perfect is the fact that bigallate of antimony settles rapidly.

In this instance, as in the case of the separation of antimony from tin by gallic acid, if bigallate of antimony refuses to settle rapidly, it is an indication that it is mixed with peroxide of tin, and the liquor should be rejected at once as useless.

In the filtrate, tin and arsenic should be precipitated by sulphuretted hydrogen in the state of sulphides, and this mixture should be separated by one of the approved methods.

Remarks.—After the separation of antimony from arsenic, from tin, or from arsenic and tin, the bigallate of antimony obtained and used for the estimation of antimony should be dissolved in weak hydrochloric acid and precipitated by sulphuretted hydrogen, when antimony ought to be precipitated after each separation in the state of that fine orange-coloured sulphide so well known.

Final Considerations.—Although the separation of antimony from arsenic and tin is a very simple one, when the gallic acid process is applied to it, I cannot say that I have succeeded in solving that most difficult of problems, an easy separation of antimony, tin, and arsenic.

I have signally failed there, where so many have failed before me, for the reason that a mixture of antimony and arsenic does not behave with reagents as a mixture of antimony and arsenic, but, on the contrary, as a new metal, *stibarsenicum*, which possesses peculiar properties and requires special reagents.

A mixture of tin and arsenic also presents all the appearance of the new metal *stannarsenicum*; and a mixture of tin and antimony all those of the new metal *stannantimonium*.

But the properties and the reagents of those three new metals being well studied and well known, it might appear that those of a mixture of the three would soon be mastered.

It is not so, however, and their mixture possesses all the characters of a new metal, *stannarsenicantimonium*, differing in properties from stibarsenicum, from stannarsenicum, from stannantimonium, from arsenic, from antimony, and from tin.

It is not, therefore, surprising that the problem of the separation of antimony, arsenic, and tin should be so difficult to solve.

The solution of this problem, however, will be found in the use of powerful reagents, capable of destroying the strange affinities exhibited by the three metals, and I have every reason to believe that organic acids will be the means of accomplishing this object.

ON THE COLOURS OF METALS.*

By Professor C. A. SEELY.

Of all the metals, two only, gold and copper, are distinctly coloured. When nicely polished the surfaces of all metals become nearly perfect mirrors, reflecting almost all the light, whatever be its tint, which falls upon them, and the chemically clean matte surfaces of all metals except gold and copper appear white to the eye. Yet the white light from such surfaces is invariably contaminated with a small amount of coloured light, and this coloured light is without doubt the result of a normal and ordinary decomposition of the incident white light. If the greater part of the incident white light were in the same way decomposed, the metals, instead of appearing to us white, would shine with splendid colours. The colours of natural objects are always mixed with white light, that is, the white light falling on the surfaces of natural objects is never completely decomposed, and in this regard the case of the metal shows a difference in degree and not in kind. To the eye of the scientist, then, all the metals may be coloured; the colours are ordinarily invisible simply because they are diluted or overpowered by the white light with which they are mingled. With the explanation thus given I assume in this paper that all metals are coloured.

The most satisfactory method of rendering the colours of metals apparent heretofore proposed consists in repeatedly reflecting a beam of white light from the metallic surface under examination. A convenient arrangement is two parallel plates of the metal, between which the

* Read before the New York Lyceum of Natural History.

light is reflected from one to the other at a small angle of incidence.

At each incidence the white light is partially decomposed, and if the number of incidences be sufficiently multiplied, all the white light will have disappeared, and only the pure coloured rays be visible. In this way the colours of most of the metals have been exactly determined. The actual experiment, however, is not a very brilliant one, inasmuch as the larger part of the light with which it begins is lost by gradual diffusion; especially the coloured light is so lost, probably for the reason that the decomposition of the white light takes place within the reflecting surface.

Another method of developing the true colours of metals has recently occurred to me, and it is the main purpose of this paper to describe it. I present first a few theoretical considerations.

When white light is decomposed by a coloured body, the reflected coloured ray is complementary to that part of the white light which is transmitted or absorbed; if a coloured body be seen both by reflected and transmitted light, the colours so seen should be complementary, or an approach to being so.

These statements seem to have many exceptions, as, for example, the coloured transparent salts of metals show the same colour by reflected as by transmitted light. But I am persuaded that a careful discussion of the case would show that such exceptions are not well taken, and that this apparent discrepancy with the statements may be consistently explained away; thus it may be shown that the supposed reflected light of the exceptions is really a part of the transmitted light which has been returned by internal reflection; such mixture of the transmitted with a reflected light implies a considerable degree of transparency of the substance under test. The lustre and whiteness of metals have a close relation to their opacity and density; perhaps the relation is that of effect and cause. If the opacity and density of metals be progressively decreased, the optical metallic character will in the same ratio be diminished; the true colour by reflected light would become brighter and freer from white light till it come to be contaminated with more and more of the returned transmitted light. Such changes are beautifully exemplified by the gradual additions of a solvent to fuchsine or other aniline colours in crystals. Aniline colours, Prussian blue, indigo, carmine, and all other dye-stuffs which have very great tinctorial powers, have the metallic lustre, and their colour by transmitted light is nearly complementary to that by reflected light.

In their relation to light I suggest that metals are closely analogous to those dye-stuffs which show a bronzed surface by reflected light. Metals are more perfectly bronzed because their opacity and density are greater, or, in other words, their tinctorial powers are greater.

It will be seen that the above theory requires for its demonstration a transparent diluent or solvent of metals, which shall have no chemical action on them. Such a solvent, for a few of the metals, is anhydrous liquid ammonia. If this menstruum be gradually added to the silver-white alkali metals, the whiteness disappears, is replaced by copper-redness, which at last gives place to the blue of transmitted light. The changes of tint in this case from copper-redness to the transparent blue may be exactly repeated by treating pure aniline blue with alcohol. The alkali metals are then copper-red in reflected light, and by transmitted light blue. In this connection, the fact that the salts of copper are blue is, perhaps, of some significance.

The solution of metals without definite chemical action is almost a new idea in chemistry. Faraday made the first approach to it by showing that the colour of ruby glass is due to metallic gold; and it received a final and definite shape in a demonstration of the solvent properties of anhydrous liquid ammonia, which I made at the late Troy meeting of the American Association for the Advancement of Science.

The tinctorial power of metals appears to be vastly greater than that of any known dye-stuff, and the colours they should yield are very brilliant. There is reason, then, to hope that these facts about metals may some day receive some useful application.

ON THE OXYCHLORIDES OF ANTIMONY.*

By WILLIAM CARLETON WILLIAMS,
Student in the Laboratory of Owen's College.

PHOSPHORUS oxychloride, $POCl_3$, having been prepared by heating together one molecule of phosphorus pentoxide with three of pentachloride, it appeared not unlikely that a similar reaction might occur with antimony giving rise to the missing oxychloride corresponding to the phosphorus compound above mentioned.

The following investigation was undertaken at Dr. Roscoe's request, with the view of elucidating the above reaction, as no oxychlorides derived from the pentachloride have as yet been described.

A mixture of one molecule of antimony pentoxide prepared by heating the pentachloride with water with three molecules of the pentachloride, was heated for some hours in sealed tubes to 140° C. On opening the tube after cooling, it was found to contain, besides unchanged pentachloride and pentoxide, two distinct solid crystalline compounds. When the pentoxide prepared by the action of nitric acid on the metal is heated with the pentachloride in a similar way no oxychloride is formed.

One of these fuses at 85° C. to a clear yellowish liquid, whilst the other, produced only in small quantities, is found adhering to the top of the tube in minute yellowish crystals, which fuse at a higher temperature. In order to obtain the first of these substances in a pure state it is sufficient to place the tube upright in a vessel of water at 90° with the empty end downwards; the fusible oxychloride then melts and collects as a perfectly clear yellowish liquid. After cooling, the tube is opened, and the small quantity of residual pentachloride having been poured off, the solid mass is dried on a porous plate over solid caustic potash *in vacuo*. The oxychloride thus obtained is a perfectly white crystalline substance, exceedingly hygroscopic, so that when exposed to the air for a few minutes it becomes a pasty mass, which rapidly changes to a liquid. It readily dissolves in an aqueous solution of tartaric acid, whilst it is decomposed by water and is perfectly insoluble in carbon disulphide. The melting-point of the substance is 85° C. as a mean of well agreeing determination made with four different preparations. When heated in a retort until it boils, chlorine gas is evolved, whilst pentachloride and trichloride of antimony distil over, a residue of antimony pentoxide remaining in the retort.

A modification of Rose's well-known method of precipitation, first as insoluble antimoniate of soda, and then as antimony sulphide, was employed for the determination of the antimony; the precipitated sulphide was (1) oxidised to Sb_2O_4 either by treatment with pure fuming nitric acid or by heating with from 10 to 20 times its weight of pure mercuric oxide, and (2) the sulphide was completely reduced to metallic antimony by heating gently in a current of hydrogen until sulphuretted hydrogen ceases to be evolved. In the estimation of chlorine it was found than when silver nitrate is added to a solution of an antimony oxychloride acidified by nitric acid, a small trace of antimony is invariably carried down with the silver chloride. In order to free the precipitate from antimony, the silver chloride is first heated gently in a current of hydrogen, when the silver is reduced, and on

* Read before the Manchester Literary and Philosophical Society, October 17th, 1871.

stronger ignition the whole of the antimony is volatilised as the hydrogen compound. Thus 1·277 grms. of an alloy, containing 2·5 parts of antimony to 97·5 parts of silver, was found to lose on heating in hydrogen 0·0321 grm., corresponding to 97·48 per cent of silver.

The accuracy of each of the above methods was tested by determining the percentage of antimony and chlorine in pure antimony trichloride, the results agreeing closely with each other and with the theoretical composition. The objection to Schaeffer's method of decomposing the oxychloride by boiling with a solution of sodium carbonate is, that the precipitated oxide of antimony being in a very finely divided state, a portion of it is very apt to pass through the filter on washing.

The simplest formula which agrees with the analytical results is $Sb_3Cl_{13}O$, or three molecules of pentachloride in which two of chlorine are replaced by one of oxygen.

	Calculated.	Found.
Sb_3	43·39	43·46
Cl_{13}	54·71	54·75
O	1·90	—
	100·00	

That this is a definite compound and not a mere mixture of pentoxide and pentachloride ($Sb_2O_5+14SbCl_5$) is evident from the fact that the latter substance is not dissolved out by washing with carbon disulphide. The calculated percentage of pentoxide contained in this compound is 7·68; on heating 2·517 grms. of the oxychloride in a tube retort a residue of 0·1799 grm. of pentoxide remained, corresponding to a percentage of 7·14.

The second oxychloride formed by heating the mixture of one molecule of pentoxide and three of pentachloride is produced only in small quantities as yellowish crystals. To obtain it in the pure state, that portion of the tube in which the substance is found is cut off, and after the tube has been re-sealed it is placed in a slanting direction in a vessel containing water heated from 85° to 90°. The $Sb_3Cl_{13}O$ melts and runs down, leaving the other less fusible oxychloride behind; this is then dried on a porous plate *in vacuo* over solid caustic potash. Two determinations showed that the melting-point of this substance is 97·5° C.

The simplest formula agreeing with the analytical numbers is $Sb_3O_4Cl_7$, or three molecules of antimony pentachloride in which 4 atoms of oxygen replace 8 of chlorine.

	Calculated.	Found.
Sb_3	53·93	53·89
Cl_7	36·62	36·58
O_4	9·44	—
	100·00	

From the above results it is clear that the simple phosphorus oxychloride is not reproduced under similar circumstances in the antimony series, but that this element in agreement with its general deportment gives rise to more complicated compounds.

The oxychlorides derived from antimony trioxide have been frequently examined; the results of the analyses of powder of algaroth made by different investigators varies considerably, and Sabanejeff has recently shown that these differences are probably due to the presence in the substance of antimony trichloride in varying quantities. This impurity he gets rid of by washing the oxychloride obtained by the action of a large excess of water on the trichloride with ether or carbon disulphide, in which the trichloride dissolves. In this way he obtains a compound having the constant composition $Sb_4Cl_2O_5$, or two molecules of trioxide in which one of oxygen is replaced by two of chlorine, whilst a simpler monoxychloride, SbOCl, is prepared by acting with only from 2 to 10 molecules of water on the trichloride. But this on treatment with ether or carbon disulphide loses trichloride and yields $Sb_4Cl_2O_5$; thus $5SbOCl = SbCl_3 + Sb_4Cl_2O_5$.

The results of my experiments lead me to the conclusion that the body obtained by the action of boiling water on the trichloride does not possess the composition—

$$Sb_4Cl_2O_5,$$

but consists of 10 molecules of this substance and one of the trichloride, which latter, however, can be removed by washing with either carbon disulphide or ether. Antimony determinations in two different preparations gave—

(1) 75·45 per cent Sb. (2) 75·88 per cent Sb; corresponding chlorine determinations gave (1) 12·43 per cent Cl; (2) 12·49 per cent Cl.

Hence we have:—

	Calculated for $10Sb_4Cl_2O_5+SbCl_3$.	Calculated for $Sb_4Cl_2O_5$.	Found.
Antimony	75·57	76·37	75·66
Chlorine	12·34	11·11	12·46
Oxygen	12·09	12·52	—

By acting upon 15 parts by weight of antimony trichloride with 1 part of trioxide in a sealed tube, Schneider (*Pogg. Ann.*, vol. cviii., p. 407) obtains a crystalline oxychloride, to which he assigns the formula $7SbCl_3SbOCl$ Repeating Schneider's experiments I obtained a pearl-grey crystalline mass melting at 72° C., the melting-point of the trichloride. When acted upon by absolute alcohol it yields powder of algaroth, $Sb_4Cl_2O_5$, and its composition appears to be even more complicated than that assigned to it by Schneider.

Antimony determinations in two specimens gave (1) 54·24 per cent Sb; (2) 54·16 per cent Sb; whilst the corresponding chlorine estimations were (1) 45·69; (2) 45·87 instead of 55·08 per cent Sb and 44·02 per cent Cl required by Schneider's formula, but agreeing with the formula $Sb_{16}Cl_{46}O$, which requires 54·2 per cent of antimony and 45·357 of chlorine.

The differences here found between the substances as prepared by Schneider and myself may arise from the admixture of antimony trioxide with the oxychloride in the former preparation. When the tube in which the substance has been prepared is placed in an upright position and allowed to cool, the undissolved oxide sinks to the bottom of the tube, but on still further cooling when the contents of the tube are about to solidify, the oxide rises from the bottom and mixes with the oxychloride. To obtain the substance perfectly free from undissolved oxide, the contents of the tube are gently heated, and when the finely divided oxide is deposited, the clear liquid oxychloride is drawn off with a pipette.

TESTS FOR NITROUS ACID.

By THOMAS M. CHATARD.

DURING the course of some work on the nitrites of nickel and cobalt, it was necessary to have an easy and accurate test for nitrous acid. I therefore reviewed all the tests given for that acid, comparing their relative degrees of delicacy, with the following results:—For testing, a very dilute solution of Fischer's salt—

$$(Co_2 6NO_2 + 6(KNO_2) + 2Aq),$$

which contained 1-200,000th part by weight of nitrous acid, was employed.

Schönbein's* test with a weak solution of indigo decolourised by potassic sulphide failed to give accurate results. Besides there are many substances which would have the same action upon the decolourised indigo as the nitrous acid.

C. D. Braun's† test with cobaltous chloride and potassic cyanide gave no reaction with so dilute a solution, even when several cubic centimetres were taken, the reaction only appearing when a comparatively strong solution of the nitrite was used.

Hadow's‡ reaction in which a nitrite when heated with

* *Jahresberichte*, 1864, 699.
† *Ibid.*, 1865, 702.
‡ *Journ. Chem. Soc.*, vol. iv., p. 341.

prussic acid, which is detected by an alkaline sulphide, gave good results only when the nitrous acid was present in larger quantities, not being delicate enough to give a reaction with the standard solution of nitrite which I employed.

A modification of this test suggested itself, in which the nitroprussic acid is thus produced. To the solution suspected of containing the acid, potassic ferrocyanide and acetic acid are added, and the whole boiled. The solution is allowed to cool, and ammonic sulphide added. If nitrous acid was originally present, the characteristic blue reaction will appear. 10 c.c. of the test solution gave the reaction, but it failed with a smaller quantity.

The problem was finally solved by another reaction, namely, the production of phenol from aniline by means of nitrous acid. Evaporate the test liquid nearly to dryness, then rub it with a few drops of a strong solution of sulphate of aniline. If nitrous acid is present, the odour of phenol will immediately result. This test is remarkably delicate, 1 c.c. of the test solution giving a perfectly distinct reaction. Nor can nitrous be confounded with nitric acid, as this last produces no phenol, but merely a yellow colour, which of itself, as is well known, is of value as a test for that acid.—*American Journal of Science.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 2, 1871.

Professor FRANKLAND, F.R.S., President, in the Chair.

THE minutes of the last meeting having been read and confirmed, the Secretary proceeded to read the list of donations, amongst which were two volumes of manuscript lectures of the celebrated Dr. Black's.

The names of the following gentlemen were read for the first time:— Charles Thomas, Benjamin Tanner, Hugh Paterson, Frederick Hicks, George Joseph Warner, Samuel William Moore, William John Wilson, William Gray, Robert Irvine, Reginald C. Woodcock, and Donald Munroe.

For the third time—R. Gerstl, Esq., who was balloted for and duly elected.

The SECRETARY then read a paper on "*A Process for the Estimation of Fluorine,*" by ARCHIBALD LIVERSIDGE, A.R.S.M., Scholar of Christ's College, Cambridge. The method employed consists in decomposing the fluoride by concentrated sulphuric acid in the presence of silica, and passing the silicic fluoride formed into solution of ammonia, the amount of silica carried over being then estimated, and the fluorine calculated therefrom. The powdered mineral is introduced into a platinum retort, similar to that described by Professor Maskelyne for the estimation of silica, together with the requisite amount of sulphuric acid and finely divided silica. It is now heated first in a water-bath and afterwards at 160° C., the gaseous silica fluoride thus formed being decomposed by passing it through a solution of ammonia, the last traces of the gas being carried over by drawing a current of air through the apparatus. The ammonia solution is gently evaporated in a platinum dish until the gelatinous silica passes entirely into solution, and it can then be precipitated as silico-fluoride of potassium by the addition of potassium chloride and alcohol. The difference between two determinations of fluorine in the same specimen seldom exceeded 0·05 per cent.

The PRESIDENT said that the thanks of the Society were due to the author for his method, as there was considerable difficulty in accurately determining the fluorine in a mineral when it was present in small quantity; but he should like to have seen the results obtained by the analysis of a fluoride of known composition, in order to be certain that there was not some constant error introduced affecting the determinations.

Dr. WILLIAMSON observed that as the mineral was only reduced to an impalpable powder, and not fused with an alkaline carbonate previous to being submitted to the action of sulphuric acid and silica, it was likely, in minerals containing but a small percentage of fluorine, that the interior of the particles might escape decomposition and thus some of the fluoride remain undecomposed in the retort. In this case the results obtained would be too low.

The next paper was on "*Anthraflavic Acid,*" by W. H. PERKIN, F.R.S. He first mentioned that Dr. Schunck had succeeded in isolating anthraflavic acid, a yellow crystalline substance accompanying artificially prepared alizarine, and to which he had assigned the formula $C_{15}H_{10}O_4$, Liebermann, also, in a paper on a "*By-Product in the Manufacture of Alizarine,*" had described a substance apparently identical with the above, the composition of which, however, he gave as $C_{14}H_8O_3$, and regarded as monoxyanthraquinone. The fact that this substance is found accompanying alizarine prepared from pure anthraquinone renders it far more probable that it contains fourteen than fifteen atoms of carbon; in order, therefore, to determine the nature of this body, the author prepared some anthraflavic acid by precipitating the pure baric salt by hydrochloric acid and crystallising the resulting acid from alcohol. It formed bright yellow silky needles, which were found to be anhydrous, and on analysis gave numbers corresponding to the formula $C_{14}H_8O_4$. Baric anthraflavate was prepared from the commercial alizarine by boiling it with baryta water, and precipitating the acid from the yellow solution by means of hydrochloric acid. The crude acid was then purified by washing it with alcohol and treating the product with dilute caustic soda, which leaves certain impurities undissolved. On adding baric chloride to the boiling solution and filtering, the baric anthraflavate is deposited in reddish-brown needles, which may be rendered pure by three or four re-crystallisations from water. The freshly crystallised salt was found to have the composition $2(C_{14}H_6BaO_4)3H_2O+10aq$; dried *in vacuo* it had the formula $2(C_{14}H_6BaO_4)3H_2O$, and at 150°, $2(C_{14}H_6BaO_4)H_2O$, the last H_2O not being driven off even at 180°. It appears, therefore, that anthraflavic acid is an isomer of alizarine, and the author finds that it accompanies the latter in variable proportion, according to the method of experimenting. Another secondary product also accompanies artificial alizarine, and like it has dyeing properties; this the author is at present investigating.

The PRESIDENT remarked that the isomerism of anthraflavic acid and alizarine was very interesting, indicating, as it did, the probability of there being other isomers, some of which might be found to have valuable dyeing properties like alizarine itself. As the author had not obtained any salt free from water, there was still some doubt as to whether it was a dibasic acid or not; but if it proved to be so, it would contain two atoms of oxatyl, COHO, leaving the residue $C_{12}H_6$, a constituent of alizarine, which undergoes the isomeric modifications. It would, therefore, be highly desirable to settle this point by preparing, if possible, some salt free from water.

Dr. ARMSTRONG said that, as he understood that Dr. Schunck had obtained anthracene by distilling the anthraflavic acid with zinc powder, it would tend to show that the nucleus contained C_{14} and not C_{12}.

Dr. MULLER suggested treating the anthraflavic acid with benzoyl chloride, as in the case of chrysophanic potassic ferrocyanide and mercuric chloride forms nitro-

acid he had obtained anhydrous substances which were well adapted for the determination of the atomic weight.

The Secretary then read a paper "*On the Distillation of Wood*," by Mr. Watson Smith. The wood preferred for distillation is oak; oak crop wood and old oak timber being the kinds generally employed. The operation lasts about eleven hours, and is known to be finished when the exit pipes from the retorts become cool. The author finds that the escaping gas burns with greater luminosity just before the completion of the distillation, and that the amount of acetic acid contained in the crude wood acid which comes over gradually increases. 1000 parts of old oak timber yielded 327 of charcoal, 509 of wood acid of sp. gr. 1·025 to 1·027, and 55 of tar. The amount of wood-spirit present in the crude wood acid varies considerably, as in one instance it was found to be in the proportion of 88 gallons of sp. gr. 862 to 1000 cwts. of wood, and in another instance only 56½ gallons of sp. gr. 883; some of the spirit is retained by the wood tar, which, on the average, contains about 3 per cent of it. The crude wood acid, after being neutralised with lime, and the wood-spirit separated by distillation, may be evaporated to dryness, when it constitutes "black acetate of lime." If instead of evaporating this liquor quickly to dryness, it be boiled down, taking care to remove the tarry matters, &c., as they form, a pellicle of calcium acetate begins to form on the surface after a time; this is skimmed off as fast as it forms, drained from the mother-liquor, and dried, when it is known as "grey acetate," a purer variety than the "black acetate."

The Society then adjourned until Thursday, the 16th of November.

CORRESPONDENCE.

ELEMENTS, COMPOUNDS, AND MIXTURES.

To the Editor of the Chemical News.

Sir,—In reference to Mr. W. H. Wood's letter (Chemical News, vol. xxiv., p. 204), I wish to point out how the "indefiniteness" he finds in chemical teaching arises from the circumstance of a word having more than one meaning. Concerning the facts themselves there is no doubt, and the elementary treatises all properly begin by stating the indisputable truth that everybody belongs to one of two classes. For either it is a body out of which it is impossible to get any other kind of matter than itself, or it is a body out of which two or more distinct kinds of matter may be obtained. Most writers use the term "compound" to designate the latter class, and when we keep in view the ground or basis of the division, we see that all mixtures must be comprehended in this class. The object of the division is to mark off from all other bodies such as are simple or elementary, and if the terms simple and not simple, or simple and complex, had been used to designate the classes there would have been no ambiguity. The word "compound," however, in its ordinary sense, expresses that which is opposed to simple and single, and is, therefore, quite appropriately employed to denote such bodies as are not elements. Thus, Dr. W. A. Miller instances earth, air, and water, as compound bodies, in a paragraph headed "Chemical Distinction of Bodies into Elements and Compounds" (Miller's "Elements of Chemistry," part 1, p. 1).

But there is another special technical sense in which the word "compound" is most used in chemistry, namely, to denote the result of that intimate union of elements which takes place according to the laws of chemical combination. In this sense the term may be opposed to "mixture." I will quote a sentence from the first page of Fownes's "Manual," where the word is obviously used first in one sense and then in the other.

"Nearly all the objects presented by the visible world are of a compound nature, being chemical compounds or variously disposed mixtures of chemical compounds."

Most teachers would shrink from formally dividing bodies into elements, compounds, and mixtures at the very outset of the subject, because while such a classification would be unnecessary for their immediate purpose, it would embarrass the student by making a distinction which, at the commencement, he would not be in a position to appreciate. Naquet, however, in his "Principes de Chemie," after ranking all bodies under two classes, simple and compound, subdivides the latter into combinations and mixtures, and then states the law of definite proportions and other characters which distinguish the sub-classes.

It occurs to me that this word "combination" is better fitted to express the result of chemical union than the word "compound." The relegation of this last to the ordinary sense, and the employment of the former in the place of the technical sense, would also prevent ambiguity.—I am, &c.,

R. Routledge, B.Sc.

Bowdon, Cheshire,
Oct. 28, 1871.

ELEMENTS, COMPOUNDS, AND MIXTURES.

To the Editor of the Chemical News.

Sir,—I would suggest that the difficulty of which Mr. W. H. Wood complains may be removed somewhat in this way.

Matter is divisible into two classes, *elements* and *composite bodies*.

An element is not resolvable into two or more different kinds of matter, a composite body is separable into two or more different substances.

Composite bodies may themselves be classified under two heads, *compounds* and *mixtures*.

A compound is a body composed of two or more elements, united in a constant proportion by weight, and its properties are not the sum or mean of those of its constituents. In a mixture, however, the constituents are not united in a constant proportion by weight, and the properties of a mixture are the sum or average of those of its components.

Mixtures may be subdivided into mixtures of the first, second, and third degrees; those of the first degree consisting of elements only, as purified air; those of the second of an element or elements, and a compound or compounds, as ordinary air; those of the third, of compounds only, as solution of nitre.

This classification may be thus summarised:—

- Matter.
  - Elements.
  - Composite bodies.
    - Compounds.
    - Mixtures.
      - 1st degree.
      - 2nd „
      - 3rd „

I am, &c.,

John E. Wright.

23, Regent Terrace, Penzance,
Oct. 28, 1871.

VAPOUR DENSITIES.

To the Editor of the Chemical News.

Sir,—I shall be glad if you can spare me space to call attention to an error in the teaching of nearly all our text-books on the subject of vapour-density determinations. If we take Roscoe's "Lessons on Chemistry," for

example, we are told that in using Dumas's method we must observe the temperature and pressure of the air in the balance-case when the glass globe is weighed full of air, but the necessity of observing these points when the globe is weighed full of vapour is not mentioned. Then, in the example given, in order to obtain the weight of the vacuous globe, the weight of air contained in the globe is deducted from the weight of the globe in air, and the weight so found is subtracted from the weight of the globe and vapour, in order to find the weight of the vapour which fills the globe.

Now, it is clear that unless we wish to go to an extreme degree of exactitude (Roscoe does not take account of the expansion of the glass) we need not observe the temperature and pressure at the *first* weighing, but must observe them at the *second*.

The observed weight of the globe full of air with the point unsealed is really the absolute weight *in vacuo* of the empty globe, minus the weight of air displaced by the glass of the globe, which is, of course, extremely small, so that this weight may be taken without sensible error as the true weight of the empty globe. Then to find the weight *in vacuo* of the globe and vapour, we must add to the observed weight the weight of air displaced at this second weighing, which may easily be considerably different from that displaced at the first weighing.

Professor Thorpe in his "Chemical Problems" follows precisely the same method as Professor Roscoe. The calculation is given correctly in the French edition of Ganot's "Physics" incorrectly in the English edition, and the error is repeated in Fownes's "Manual of Chemistry," in Pouillet-Müller's "Lehrbuch der Physik," in Kekulé's "Lehrbuch der Organischen Chemie," and (with the addition of a misprint) both in the French and English editions of Deschanel's "Traite de Physique." The same mistake appears even in Watts's "Dictionary of Chemistry," the formula in which seems to be taken from Regnault's "Cours de Chimie." Regnault also directs to observe the barometer and thermometer at the first weighing, but takes care to say that, in case the pressure and temperature alter before the second weighing, it will be necessary to introduce a correction. It is clearly better to observe the temperature and pressure at the second weighing, and if then there is any difference between these conditions at the two weighings the correction to be introduced will be much less.

The calculation is given correctly in Cooke's "Chemical Physics."

Of course no chemist in the habit of making vapour-density determinations is likely to fall into such an error, but it is extremely undesirable that in books designed for teaching a necessarily complicated subject should be rendered more difficult by the use of roundabout or erroneous methods.—I am, &c.,

W. MARSHALL WATTS.

MISCELLANEOUS.

University of London.—The following are lists of the candidates who have passed the recent B.Sc. examinations:—*Pass Examination.*—First Division. Thomas Olver Harding, B.A., Trinity College, Cambridge; Robert Moses Lewis, B.A., Downing College, Cambridge; Thomas Hutchinson Waller, B.A., Private study. Second Division. George Thomas Betany, Caius College, Cambridge; John Cameron Graham, University College and private study; Marcus Manuel Hartog, University College, London, and Trinity, Cambridge; John Landor Lowe, King's College; William Thomas Rowden, Royal School of Mines; William Whitchurch Taunton, University College; William Thorp, private study; George Mathews Whipple, private study.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Annalen der Physik und Chemie, von Poggendorff, No. 7, 1871.

This number contains the following original papers and essays relating to chemistry and collateral sciences:—

Expansion of a Drop of Liquid on the Surface of another Liquid.—Dr. C. Marangoni.

Thermo-Chemical Researches.—J. Thomsen.—The continuation of a very lengthy essay on this subject. This portion contains the following sections:—On the quantity of heat evolved by the neutralisation of bases; lithia, soda, oxide of thallium, baryta, strontia, lime, and ammonia; magnesia, protoxides of iron, manganese, oxides of nickel, cadmium, zinc, and copper. To be continued.

Description of a Pressure Guage for Measuring High Pressure of Gases.—V. Regnault.—Illustrated with engravings.

Researches on the Electro-Motive Force Evolved by the Contact of Different Metals, and on the Effect which Heat has thereon.—E. Edlund.—This lengthy essay is illustrated by engravings.

Refraction and Dispersion of Selenium.—J. L. Sirks.—An algebraico-optical essay.

Colouration Exhibited by Turbid Substances, and on the So-Called Coloured Photography.—C. Schultz-Sellack.

The Crystalline Form of Scheelite.—Dr. M. Bauer.—A strictly crystallographical paper. Scheelite is tungstate of lime.

Isomorphism of the Triclinic System of Crystals.—G. Tschermak.

Preparation of Pure Chromic Acid.—E. Zettnow.—After referring at length to the experiments on this subject made by Kuhlmann, Fritsche, Warrington, and Traube, the author describes a series of experiments made with the view to ascertain the best method to prepare chromic acid in the pure state, of which the following is an outline:—For 300 parts of the commercial bichromate, 500 c.c. of water and 420 c.c. of strong sulphuric acid are taken; when, after about ten to twelve hours, the bisulphate of potassa has crystallised out, the liquor is decanted, and the crystalline mass washed with about 12 c.c. of water. The solution of chromic acid having been heated to 90°, there are added to it 150 c.c. of strong sulphuric acid, and next just as much water as is sufficient to dissolve the chromic acid which has been precipitated in the flocculent state. The solution is then evaporated until a crystalline film appears on the surface of the liquid, which is then set aside to cool until, after some 10 to 12 hours, a first crop of crystals has separated; by a further evaporation of the mother-liquor more crops (two to three) of crystals may be obtained. Since the crystals of the chromic acid are very small, it is best to decant the liquid by filtration through a cone of platinum foil perforated with many small holes, in order to free the chromic acid completely from adhering sulphuric acid. The author washes the crystals with nitric acid, sp. gr. = 1·46, which acid ought to be pure. It dissolves hardly any chromic acid, but eliminates the sulphuric acid completely.

Specific Gravity of Pure Chromic Acid and of some of its Solutions.—E. Zettnow.—The author employs benzine for the purpose of taking the sp. gr. of the acid here alluded to; the average sp. gr. of crystallised chromic acid is 2·78, while that of the fused acid is 2·802.

Preparation of Crystallised Chromium.—E. Zettnow.—To 100 parts of bichromate of potassa are added 300 c.c. of rough hydrochloric acid, 150 c.c. of water, and 80 c.c. of alcohol at 80 per cent. To this fluid mixture, which becomes spontaneously very hot, are added 180 parts of chloride of potassium, and the whole evaporated to dryness, next gently ignited in a crucible so as to drive off all water, and the dry mass after having been broken up into small lumps is divided into four equal parts, and to each of these is added 50 parts of small chips of zinc-foil. This mixture keeps perfectly well in dry and stoppered bottles, but deliquesces by exposure to air. Each portion of this mixture is gradually placed in a bright red-hot crucible, and after the reduction of the chromium has taken place and the mass is cooled, it is first boiled along with water, and then treated with very pure and very dilute nitric acid, which dissolves the zinc and leaves the chromium in crystalline form. The author intends to publish further details on this metal in a future paper.

Apparatus for Exhibiting Momentum (Vis Inertiæ).—A Kurz.—Accompanied by engravings.

Erythroscope and Melanoscope.—E. Lommel.—An optical treatise.

No. 8, 1871.

This number contains the following original papers and memoirs:—

Continuation and End of Essay on Thermo-Chemical Researches.—J. Thomsen.

Researches on the Electro-Motive Force Evolved by the Contact of Different Metals and on the Effect which Heat has thereon.—E. Edlund.—Continuation and end of this very exhaustive essay.

Behaviour of Chlorophyll towards Light.—Dr. E. Lommel.

Action of Light upon Chlorophyll.—Dr. E. Gerland.—The contents of these essays are not suited for useful abstraction.

Water and Common Salt Contained (Occluded) in Rocks and Minerals.—Dr. F. Pfaff.—This paper, illustrated by several engravings, treats on the method of determining the quantity of water mechanically occluded between the pores and particles of rocks and minerals, while it appears that in many instances this water contains common salt also. The main result of the author's researches are:—All granitic rocks contain water mechanically occluded between the component crystals; the quantity of this water varies considerably, viz., from 0·11 to 1·8 per cent; the rocks alluded to and also the sedimentary rocks contain, in addition to water, chloride of sodium occluded; no water was found in any kind of lava, obsidian, and basalt.

On Sulphur Crystallites.—H. Vogelsang.—This paper is a reply to some critical observations made by Dr. E. Weiss on an essay published by the author some time since on crystallites.

Limits of the Sensitiveness of the Eye for Spectrum Colours.—S. Lamansky.—An algebraico-optical essay; an observation also relating to the following essay:—

The Spherical Electro-Dynamometer.—O. Frölich.

Spectra Exhibited by Lightning.—Dr. H. Vogel.—The account of spectrum observations made on the lightning during a severe thunderstorm, which lasted for several hours, on September 2 last.

On Coloured Gelatine as Suitable Objects for the Spectroscope.—E. Lommel.

Bulletin de l'Academie Royale des Sciences, des Lettres et des Beaux Arts de Belgique, No. 8, 1871.

This number contains the following papers relating to chemistry:—

New Mode of Formation of Diethylic Sulphate.—E. Dubois.—After referring to researches made by Dr. Odling and M. Baumstark, the author describes some of his experiments on the action of chloride of sulphuryl upon alcohol. The reaction is very violent, and the result is the formation of a body, $(C_2H_5)_2SO_4$, according to the following formula:—

$$SO_2Cl_2+4C_2H_5.HO=(C_2H_5)_2SO_4+2C_2H_5Cl+2H_2O.$$

Conversion of Citric Acid into Tricarballylic Acid.—E. Dubois.—The author begins this essay by observing that on examination of the three following formulæ:—

$C_3H_5\{CO_2H,CO_2H,CO_2H$	$C_3H_3\{CO_2H,CO_2H,CO_2H$	$C_3H_4(HO)\{CO_2H,CO_2H,CO_2H$
Tricarballylic acid.	Aconitic acid.	Citric acid.

it will be observed that there exist between these acids the same relation as exists between the following acids:—

$C_2H_4\{CO_2H,CO_2H$	$C_2H_2\{CO_2H,CO_2H$	$C_2H_3(HO)\{CO_2H,CO_2H$
Succinic acid.	Fumaric acid. Maleic acid.	Malic acid.

The author next states that, by the aid of the action of iodhydric acid (at 50° B.) upon citric acid, continued for thirty hours, he has succeeded in converting the citric acid into tricarballylic acid, fully identical in every respect with the properties of that body and its salts as described by Dr. Maxwell Simpson.

The American Journal of Science and Arts, October, 1871.

This number contains, in addition to the lengthy papers and essays on geology, palæontology, natural history, and astronomy, the following paper which, to some extent, bears on chemistry:—

The Paragenesis and Derivation of Copper and its Associates on Lake Superior.—R. Pumpelly.—The continuation of a lengthy essay on this subject, setting forth the mode of formation of the minerals met with along with the metallic copper deposit alluded to. This paper is to be continued.

Journal für Gasbeleuchtung und Wasserversorgung, No. 18, 1871.

The original matter contained in this number only refers to gas- and water-works' engineering and management.

Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin, August, 1871.

The original papers relating to chemistry and published in this number are:—

Second Paper on the Native Compounds of Tantalum and Niobium.—Dr. Rammelsberg.—The continuation of an exhaustive mineralogical essay on this subject, to which are added a very large number of chemical analyses of the minerals yttrotantalite, Fergusonite, bragite, tyrite, euxenite, and others herein treated of.

Methylisation of the Phenyl Group in Aniline.—Dr. A. W. Hofmann.—This lengthy essay, elucidated by a series of complex formulæ, contains the following sections:—Introduction; dimethyl-aniline; dimethyl-toluidine; dimethyl-xylidine; dimethyl-cumidine; dimethyl-cymidine.

Journal für Praktische Chemie, Nos. 15 and 16 (double number), 1871.

Nos. 13 and 14 of this periodical will be abstracted as soon as we obtain them. This number contains the following original papers and memoirs:—

Contribution to our Knowledge of some of the Chromium Compounds.—L. J. Heintze.—This essay treats at great length on the author's results of experiments, made with the view of preparing amido-chromium compounds. We regret that the great length of this succinctly-written memoir does not admit of any further account than the quotation of the headings of the different sections:—Introduction; action of ammonia upon potassium chloro-chromate; action of ammonia upon chromic acid chloride.

Mineralogical Notice.—A. Frenzel.—This paper treats on Pucherite, a mineral named from the locality, Pucher-Richtschacht, Saxony, where it occurs. This substance has a sp. gr. = 5·91, and is a compound of oxide of bismuth and vanadic acid; formula, $Bi_2O_3.VO_5$. In 100 parts:—Oxide of bismuth, 71·49; vanadic acid, 28·51. The main portion of the contents of this paper are strictly mineralogical.

Action of Light upon Chlorine and Bromine.—E. Budde.—This paper contains a preliminary account of a series of experiments, made with the view of inquiring more accurately into the phenomena of combustion and catalysis. The following points deserve notice:—Light decomposes the molecules of chlorine; highly refrangible light has upon chlorine an effect not quite known by being converted into heat, giving rise to the expansion of this gas; the division of the spectrum, adopted by Seebeck and Melloni, into a heating and non-heating chemically active portion, is not correct, because there exist bodies which are far more heated by the violet- than by the red-coloured rays; in fact, the division alluded to only applies to surfaces covered with lamp-black; bromine behaves as chlorine does.

Table Exhibiting the Quantity of Neutral Molybdate of Soda in Aqueous Solution.—B. Franz.

The Methods (Moden) of Modern Chemistry.—Dr. H. Kolbe.—Notwithstanding the high scientific value of this lengthy and very carefully written essay, its contents are not suited for useful abstraction, an observation also applying to the following paper:—

On some Electro-Capillary (Chemosmotic, Chemosmotische) Phenomena.—O. Loew.

Theoretical Observations on the Colours Exhibited by Bodies.—W. Stein.—This essay contains some very important facts bearing upon a difficult subject, but does not admit of any further quotation.

Estimation of Sulphur in Ultramarine.—W. Stein.—The main gist of this paper is that, instead of arsenious acid, sulphate of copper, but not chloride of copper, may be advantageously used.

Essay on the Spectrum of Calcium.—R. Blochmann.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, October 26, 1871.

This number contains the following original papers:—

Continuation of the Memoir on the Dissociation of Bodies.—C. Mène.

New Method of Preparing Pulp for Paper-Making Purposes from Wood.—M. Cattell.—The detailed description of a series of mechanical and chemical operations by which paper-pulp may be obtained from wood.

Bleaching Cotton, Hemp, Flax, Jute, and other Vegetable Fibres, by the Aid of Permanganates.—Tessié du Motay.—The description of a certainly very effective, but also rather complicated, process of bleaching, requiring not only permanganates, but, after its application, sulphurous acid, and then again alkalies.

Bibliography.—Under this title we call attention to the following works:—"Exposé d'un Système à Vapeur Economique ou à Détente très Prolongée," par M. Autier; a volume containing engravings. The contents of this work are highly spoken of, and specially worth notice on account of the greatly lessened consumption of fuel by the adoption of the author's system now in practice in several parts of France. "De la Notation Atomique et de sa Comparaison avec la Notation en Equivalents," par le Dr. Micé, chez Baillière, Paris. The contents of this work are, according to the short review here given, well worthy the attention of all scientific chemists.

November 2, 1871.

This number contains the following original essays and papers:—

Continuation of the Studies on the Chemical Dissociation of Bodies.—C. Mène.

Chemical Researches on Food Substances.—C. Mène.—The first portion of an elaborate chemico-physiological memoir, treating on digestion as an introduction.

New Apparatus for Heating Wines.—C. Tellier.—This paper, illustrated by woodcuts, describes a contrivance for ameliorating and maturing wines by the aid of heat.

Varying Quantity of Alcohol met with in the Wines Produced in Different Countries.—Drs. Blaukenborn and Roesler.—A tabulated form exhibiting the names of different wine-growing countries

their mean annual temperature, the sp. gr. of the wines, and quantity of alcohol by volume per cent contained therein.

Bibliography.—Under this heading are published short reviews of the two following recently published books:—"Traité Complet de la Tourbe," par M. E. Bosc. From what is here published on this work it appears to deserve the notice of all who are interested in the question of the best and most advantageous modes of utilising peat. "Essai sur les Gravures Chimiques en Relief," par M. Motteroz. This work contains all, and the best, information on the subject of substituting for xylography a more rapid and yet equally satisfactory method of producing engravings which can be printed along with ordinary type.

Gazzetta Chimica Italiana, No. 7, 1871.

This number contains the following original papers and memoirs:—

Action of Perchloride of Phosphorus upon Bichloride of Aldehyde.—E. Paterno and G. Pisati.—The main results of this excellent essay may be *resumèd* as follows:—Pure bichloride of aldehyde behaves with perchloride of phosphorus in the same way as do all the aldehydes, giving rise to the formation of a compound of the formula $C_2H_2Cl_4$; while, by the reaction which takes place, there is always formed a small quantity of the compound $C_4H_4Cl_6O$, due to the impossibility of completely excluding hydrochloric acid.

Presence of Manganese in Blood as a Permanent Constituent of that Liquid.—G. Campani.—This subject has been taken up by the author in consequence of a paper published in another scientific Italian periodical, wherein Dr. Pollacci asserts that manganese is an integral constituent of blood. It appears from the author's experiments, made with blood of oxen, that the globules as well as the serum contain, along with iron, weighable quantities of manganese.

Spectroscopical Characters of an Ammoniacal Solution of Carmine, of Cochineal, and of other substances.—G. Campani.

Urea a Product of the Spontaneous Decomposition of an Aqueous Solution of Hydrocyanic Acid.—G. Campani.—By the slow decomposition of the acid alluded to, there is formed, in addition to a brownish coloured amorphous substance (paracyanogen), a crystalline compound, which, on being tested with nitrate of mercury and other reagents, was found to be urea.

Contribution to our Knowledge on Sulphide of Carbon.—F. Sestini.—This paper is as yet only an abstract of an essay on this subject, but from what is here published we learn that sulphide of carbon is not quite insoluble in water, for if the sulphide is agitated along with pure water for several hours a perfect aqueous solution of the sulphide of carbon is obtained, which contains by weight 1 part in 1000 of water. When a mixture of water, of hydrate of lime, and of sulphide of carbon, is exposed to the action of the sun's rays, there is formed sulphocarbonate of lime, a reddish coloured solid substance, $3(CaH_2O_2)+CaSC+7H_2O$. As a very delicate test for sulphide of carbon, the author makes use of the aqueous solution of the sulphide, to which is added some solution of caustic potassa, and this mixture heated for five minutes to 50°; when then acetate of lead is added an abundant precipitate of sulphuret of lead is formed. The author states that by this test 1-10,000th part of sulphide of carbon may be detected.

No. 8, 1871.

This number opens with a lengthy essay:—

On a Supposed New Volcano in Sicily.—O. Silvestri.—A geologico-chemical paper of importance, especially to elucidate volcanic action.

Action of Sunlight upon Olive Oil.—L. Moschini.—The main point of interest in this paper is that olive oil, in its natural state, contains in solution a yellowish coloured substance, which, when acted upon by sulphuric adid (sp. gr., 1·63) and by nitric acid (sp. gr., 1·33), gives rise to a greenish colouration, while, with caustic soda solution (sp. gr., 1·34), a bright yellowish colouration is produced. After exposure to sunlight this coloured substance is so modified that the reagents alluded to do not produce the same reactions; moreover, by the action of the sun, the oleine of the oil is entirely altered, imparting to it many of the properties of elaidine, while, if the action of the sun's rays is very prolonged, there are free acids formed, and the olive oil becomes rancid.

Pharmaceutische Zeitschrift für Russland, Nos. 12, 13, and 14, 1871.

These numbers do not contain any original papers relating to chemistry and allied sciences.

No. 15, 1871.

This number contains the following original paper:—

On Picrotoxin and some of its Derivatives.—Dr. J. Gaabe.—This exhaustive essay obtained the golden Suworow medal from the Medical Faculty of the University of Dorpat. The first part of this paper gives a detailed account of all that has been done as regards chemical research of the so-called *Cocculus indicus*, the berry of the *anamirta*, or *Menispermum cocculus*, from 1730 (C. Neumann) up to the present day. The second portion of this paper records the author's experiments, divided into the following sections:—Preparation of pure picrotoxin; action of caustic potassa solution upon picrotoxin; action of sulphuric acid upon picrotoxin. From the tabulated form printed at the end of this essay we learn that the following are the main results of this research:—Picrotoxin, $C_{12}H_{14}O_6$; hydropicrotoxin, $C_{12}H_{16}O_8$; oxypicrotoxin, $C_{12}H_{14}O_6$; oxyhydropicrotoxin, $C_{12}H_{16}O_7$; dioxypicrotoxin, $C_{12}H_{14}O_7$; dioxyhydropicrotoxin, $C_{12}H_{16}O_8$; trioxypicrotoxin, $C_{12}H_{14}O_8$; trioxyhydropicrotoxin, $C_{12}H_{16}O_9$.

No. 16, 1871.

This number contains no original papers relating to chemistry.

NOTES AND QUERIES.

Lute.—(Reply to W. S.)—Loam or pipe-clay will probably answer your purpose.

Paraffin and Naphthalin.—Could any of your readers inform me of a method of testing the difference between paraffin and naphthalin? I have a lot of solid matter that comes off at a temperature of 370° to 450° F., or before all the light oil is off in the distillation of tar.—Thomas Danks.

Elements, Compounds, and Mixtures.—With reference to the questioned raised by Mr. W. H. Wood in your last number, permit me to quote the following from page 3 of Dr. Miller's useful little "Introduction to Inorganic Chemistry"—"Every material object with which we are acquainted is, in a chemical point of view, either an element or a compound, or else a mechanical mixture of two or more elements or compounds." This appears to meet the case of natural mixtures having, within certain limits, a definite composition.—George Chaloner, Birkbeck Institution.

Purifying Coal-Gas.—(Reply to M. H.)—The gas which is supplied from the gas-works is not, as a rule, too impure for heating purposes, but if you desire it purer, especially as you only appear to require it on the small-scale, pass the gas, previous to burning it, through an alcoholic solution of caustic potassa or caustic soda, whereby you will eliminate from the gas any sulphide of carbon and sulphuretted hydrogen it might happen to contain. If, however, you make your own gas, try the processes described by the Rev. W. R. Bowditch, M.A., in his work "The Analysis and Purification of Coal-Gas," published by Messrs. Spon; London, 1867.

Gallic Acid.—Hugo Tamm writes in a dashing, confident style, but wherefore does he notate gallic acid as $C_7H_1O_2$? (C=6, O=8)? M. Schiff regards—

Gallic acid as	$C_{14}H_6O_{10}$
Tannic acid	$C_{28}H_{10}O_{18}$
Tannin	$C_{54}H_{22}O_{34}$

The formation of these bodies conform to a generic formula of production.

Gallic acid + gallic acid − 2HO = digallic (tannic acid).
3 Gallic acid + sugar − 6HO = tannin, or trigallic glucoside.

The relation of tannic acid to anthracen and many other items seem to justify the latest opinion of that distinguished chemist.—S. E. P.

MEETINGS FOR THE WEEK.

Monday, Nov. 13th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "Nervous Matter: its Structure and Properties."
Thursday, 16th.—London Institution, 7.30. Harry G. Seeley, F.G.S., on "The Influence of Geological Phenomena on the Social Life of the People."
—— Chemical, 8.

TO CORRESPONDENTS.

*** Vol. XXIII. of The Chemical News, containing a copious index, is now ready, price 11s. 4d., by post, 12s., handsomely bound in cloth, gold-lettered. The cases for binding may be obtained at our office, price 1s. 6d. Subscribers may have their copies bound for 2s. 6d. if sent to our office, or, if accompanied by a cloth case, for 1s. Subscribers wishing to complete their sets of volumes are requested to apply to the publisher, who will give them information respecting scarce numbers and volumes. Vol. xxiv. commenced on July 7th, and will be complete in twenty-six numbers. Reading Cases, price 1s. 6d. each, post free, may also be obtained at the Office.

Errata.—Vol. xxiv., p. 208, col. i., line 7 from bottom, *for* "$SbO_3(C_7HO_2)_3HO$" *read* "$SbO_3(C_7HO_2)_3+3HO$." Col. ii., line 6 from top, *for*—
(1.) "$SbO_3(C_7HO_2)_2+3HO$." (2.) "$SbO_3(C_7HO_2)_2+5HO$," *read* "$SbO_3(C_7HO_2)_3+5HO$."

C. S. E. Wood.—You will find the information you require in Crookes and Röhrig's "Metallurgy," vol. ii.

X. Y.—Hypochlorite of lime liquor is made by passing chlorine gas through a mixture of lime and water placed in cisterns; the solution possesses similar properties to dry bleaching-powder.

J. Leith.—A work treating on the subject is in the press.

THE CHEMICAL NEWS.

VOL. XXIV. No. 625.

GALVANIC BATTERY ELEMENTS.

By W. H. COFFIN.

HAVING made a series of tests with various galvanic elements, with a view of determining experimentally their respective adaptabilities for telegraphic, signal, clock, and other work, their relative cost, constancy, and strength; I send you a brief account of the results, thinking them to be of sufficient general interest.

The following cells were prepared:—

(*a*). Leclanché's. Zinc, ammonic chloride solution in water, and manganic oxide mixed in the state of coarse powder with fine crushed best gas carbon, and packed with larger pieces of carbon in porous cell around carbon block. Reduced probably to dimanganic trioxide.

(*b*). Similar to (*a*), with the substitution of plumbic peroxide for manganese, and sulphuric acid 1 to water 25 for ammonia solution.

(*c*). A modification of Marié-Davy's element, zinc, sulphuric acid 1 to water 25, and mercuric sulphate; securing equal electromotive force with much greater constancy.

(*d*). Zinc, water, and plate of carbon; the latter descending to the bottom of receptacle, and dipping into a layer of mercuric sulphate. Zinc and carbon closely approximated, no porous division.

(*e*). Highton's new element, zinc, ammonic sulphate solution in water, and carbon in porous cell, packed with crushed carbon, and surmounted by a tower of cinders. Was made as closely as possible according to the inventor's description, the porous cell being selected for porosity and size, being three inches in diameter, and extending to about six inches above the surface of the solution, the upper part pierced with numerous holes.

(*f*). Zinc, sulphuric acid 1 to water 25, and carbon packed exactly as in (*a*), minus the manganese.

(*g*). New cell.

(*h*). New cell.

(*i*). New cell.

The elements (*c*), (*g*), (*h*), (*i*), if still satisfactory after further research and modification, will be made public.

All zincs exposed equal surfaces to solution. Porous cells, with the exception of (*c*) being precisely similar, and saturated for an inch from the bottom with paraffin. Chemicals, with the exception of acids, being the ordinary ones of commerce; zinc well amalgamated, ordinary best Belgian rolled, and the weight of substances at the negative pole being in each case, except (*e*) and (*f*), sufficient to neutralise the hydrogen displaced by one ounce of zinc.

Current variations were determined by a very sensitive tangent galvanometer, having a diameter-needle ratio of 20, R=0·09 Ohms, and reading easily by estimation to 15′ or 20′.

A word of explanation will be necessary respecting the electromotive forces as entered in the table. These were measured after poles were connected for two seconds by a small resistance of 0·197 Ohms. By this method I think a more correct estimate can be made of the practical value of the element, for the potential, though constantly falling on short circuit, decreases to a very remarkable extent during the first two seconds only, the fall after that interval being inconsiderable in comparison; the ratio between the force tending to produce a current, and the current that can be maintained, even on long circuit, differs to a remarkable extent between the various descriptions of cells; for example—the element (*a*), by connecting with a condenser of not too extensive a surface, and discharging through galvanometer, indicates about 1·49 volts, whereas, if tried after two seconds current through 0·197 Ohms, indicates as in the table only about 1·137 volts., being then considerably less than some elements whose initial forces are much less than that of (*a*) at first.

It is quite evident that the force as estimated by first method is seldom, if ever, available in practical telegraphy, especially in charging cables of great electrostatic capacity, whereas, by the method pursued here, results are obtained that can be accepted with confidence. The electromotive force was in each case every time determined by three distinct methods, namely—that indicated above; the method of Fechner or Wiedemann of sum and difference in comparison, the galvanometer above alluded to being employed; and the other method due to Fechner, of direct comparison through high resistance, using a sine galvanometer of great delicacy, having 2000 turns of fine wire, and a resistance of about 4560 Ohms.

Zincs being weighed and poles insulated for 60 minutes, the potentials (*c*) were measured and inserted in col. 2 of table. After thirteen hours open they were coupled in series, each one working through resistance of $R=\Sigma r+0{\cdot}197$ Ohms. for 60 minutes, the variation in current strength during that interval being as in col. 3, the signs + (inferred) and − denoting in this and all other determinations of current variation an increase or decrease in the same, respectively, unity being taken as that current producing a deflection of 45° on a certain galvanometer. 36 hours from this, with poles insulated in the interval, E was again measured and inserted in col. 4. Working in the same conditions as in col. 3 for 6 hours, the variations were as in col. 5, after which the variations with open poles in 15 minutes were entered in col. 6. Col. 7 shows the potentials one hour after last experiment. In col. 8 is the variation in 12 hours through $R=\Sigma r+379$ Ohms. Cols. 9, 10, and 11 show the variation in three consecutive intervals of 5 minutes each, through R=0·197 only. Col. 12 contains the variation in the next 5 minutes through R=O. The potentials after 2 hours' open poles were then found to be as in col. 13. Poles were insulated for eighteen days, and loss of zinc since beginning of experiments was found to be as in col. 14, in grs. The absolute resistance of each cell was undetermined, but their relative resistances were measured both before and after tests, and in cols. 15 and 16 are indicated by numbers the inverse order of their resistances—that is to say, from the most to the least conductable, before and at the termination of the experiments respectively.

The zinc of (*a*) was in the best condition, smooth and clean, but with a few small crystals, and a fine black pulverent non-adhesive deposit; (*e*) was slightly more attached, but covered with a quantity of large crystals, forming a continuous coat; (*c*), (*g*), (*h*), (*i*), were quite clean, but slightly pitted and rough on surface; (*b*) was quite dirty, very rough, and showing traces of much local action; (*d*) was very much attacked, great local action. These results, I think, afford sufficient data for valuable inference. I should select (*g*) where great constancy was particularly essential and final cost a consideration; the negative pole of this element being absolutely perfectly insoluble in the solution, unaffected by it for any length of time, and the cost of replacing it very small indeed. When continuous action with high electro-motive force is required, element (*c*) is indicated. The same on short circuit, where conductivity is and expense is not a consideration, will indicate (*d*). When the battery is not to be called upon for an indefinite period of time, and then only occasionally on long circuit, element (*a*) should be selected, especially if it is to be placed in inaccessible positions, the cost of maintenance under such circumstances being remarkably small. When, however, great economy in working is essential, and constancy not particularly necessary, the element (*e*) is certainly the best if it is to be rather constantly used, and on long circuit.

Elements.	2. E initial.	3. Var. 60 mins. after 13 hours. R=∑r=0·19.	4. E, 36 hours after.	5. Var. 6 hours. R=∑r=0·19.	6. Var. 15 mins. R=∞.	7. E, 1 hour after.	8. Var. 12 hours. R=∑r+379.	9. Var. 5 mins. R=0·197.	10. Var. 5 mins. R=0·197.	11. Var. 5 mins. R=0·197.	12. Var. 5 mins. R=0.	13. E, 2 hours after.	14. Loss zinc. Grains.	15. Order of $\frac{1}{R}$ initial.	16. Order of $\frac{1}{R}$ final.
). $(MnO_3)(NH_4Cl)$ ..	1·115	−1·110	1·137	−0·653	0·326	0·773	−0·685	−0·566	−0·056	0·000	−0·168	1·046	72·0	5.	3.
(*b*). $(PbO_3)(SO_4H_2)$ ..	1·326	−0·790	1·340	−0·618	0·059	0·792	−0·059	−0·519	−0·180	−0·100	−0·090	1·090	533·5	7.	6.
(*c*). New cell	1·346	0·087	1·457	−0·594	0·594	1·237	−0·061	−0·550	0·000	0·000	−0·570	1·286	129·2	2.	2.
(*d*). $(SO_4H_2)(H_2O)$ ..	1·354	−0·408	1·352	0·000	0·000	1·230	0·172	−0·224	−0·304	−0·072	−0·111	1·314	800·0	1.	1.
(*e*). $[SO_4(NH_4)_2]$ ..	1·224	−0·205	1·181	−0·490	0·080	1·162	−0·393	−0·330	−0·105	−0·020	−0·203	1·080	96·0	3.	7.
(*f*). $(C)(SO_4H_2)$.. ..	1·245	−0·236	1·009	−0·055	0·040	0·699	−0·127	−0·148	−0·022	−0·022	−0·028	0·990	0·0	9.	9.
(*g*). New cell..	1·080	0·218	1·120	0·017	0·087	1·068	0·000	−0·096	0·000	0·000	0·018	1·050	139·0	4.	4.
(*h*). New cell	1·109	−0·018	1·146	0·000	0·070	1·036	0·114	−0·219	−0·079	−0·013	−0·028	1·050	157·0	8.	5.
(*i*). New cell..	1·325	−0·079	0·623	0·000	0·000	0·618	0·052	−0·024	0·000	0·000	−0·012	0·598	132·0	6.	8.

NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

III.

Uric acid ($H_2C_5H_2N_4O_3$). White crystalline powder, 1 part soluble in 10,000 parts water. Crystallises in rhombic tables; these are modified in the presence of colloid matters, and form lozenges, as in morbid urine. It combines with bases to form salts, as urate of ammonium, which so frequently separates from the urine on cooling, and is again dissolved by heat.

Uric acid occurs most largely in the excrement of serpents, which consists almost wholly of urate of ammonium. It is contained also in healthy urine and in the blood, traces in the sweat (Stark), &c.; in some morbid states of the system uric acid is abundant, separating from the urine in red grains, and in gout is secreted by the synovial membranes as urate of lime.

Uric acid may be readily obtained from urine by evaporating to ⅓th part of its bulk and adding HCl, when the crystals separate. In abnomal urine the simple addition of HCl is sufficient if the acid be present; to demonstrate it in gouty blood, Garrod recommends that the blood be acidulated with acetic acid, a thread placed in it and left for twelve hours, crystals then form on thread; this is conveniently done in a watch-glass.

Calculi frequently occur composed of impure uric acid, though sometimes in combination with a base.

The best method of obtaining pure uric acid is to dissolve boa excrement in KHO and add HCl, collect the precipitate and repeat the operation, when, on drying, you will have the acid pure.

Decomposition Products.

Uric acid is readily acted on by oxidising agents, and a large number of products obtained; the most important are the following:—

Alloxan ($C_4H_4N_2O_5,3H_2O$). Obtained by adding dry uric acid to HNO_3, sp. gr. 1·42, keeping the vessel cool as violent effervescence ensues. When sufficient uric acid is added, alloxan separates in crystals.

It crystallises in octahedra, which become pink by exposure to light; a solution stains the skin pink, and communicates a sickly odour. Alloxan is not acid, but reddens litmus paper, and gives a purple reaction with a ferrous salt.

Alloxanic acid ($H_2C_4H_2N_2O_5$). Treat alloxan with BaH_2O_2 until precipitate does not dissolve, and gently heat; baric alloxanate produced. Add cautiously H_2SO_4, filter and evaporate; crystals of the acid form.

Mesoxalic acid ($H_2C_3O_5$). Boil baric alloxanate and baric mesoxalate precipitates; H_2SO_4 sets the acid free; it is very soluble.

Parabanic acid ($H_2C_3N_2O_3$). Obtained from the mother-liquor of alloxan by concentration and crystallisation.

Ammonium parabanate on evaporation breaks up into ammonium oxalurate; H_2SO_4 sets free the acid.

Alloxantin by reducing alloxan with H_2S, &c.

Boiling solutions of alloxantin and NH_4Cl mixed in a tube, corked, and cooled, form crystals of uranil.

Murexid or purpurate of ammonium may be obtained by adding alloxan to an ammoniacal solution of uranil; thus, step by step, we descend the ladder of the series, keeping the original uric acid still in sight.

The production of murexid is the most characteristic test for uric acid. A portion of the substance is dissolved in HNO_3, the solution evaporated to dryness and ammonia added, if uric acid be present, murexid is formed; this is changed to a violet colour by adding KHO.

From what we have now seen in the changes this body may undergo, it is not improbable that in the animal economy many phases of disease are dependent on the imperfect modifications of this acid, its oxidation being arrested at too early a period or advanced beyond its proper limit.

Allantoin occurs in the allantoic fluid of the fœtal calf, and is procured by oxidising uric acid.

There are many other derivatives, but most of them are comparatively unimportant.

Cystin occurs in a rare form of calculus, and is, perhaps, strictly a pathological product; its formula is $C_3H_6NO_2S$. It contains 25·5 per cent of sulphur, and crystallises in haxagonal plates from its solution in ammonia; when heated it gives off a fœtid odour.

Hippuric acid ($HC_9H_8NO_3$) is present in large quantities in the urine of herbivora; traces occur in healthy human urine. This acid is closely allied to benzoic. If a horse be kept at rest no change occurs in the hippuric acid, but when worked it changes to benzoic; when benzoic acid is taken by man it is converted to hippuric acid in the urine.

Its constitution seems to be that of glycocine with an atom of H displaced by benzoyl, $HC_2H_3(C_7H_5O)NO_2$. It crystallises in rhombic prisms, and may be obtained from cow's urine by acidulation with HCl, in long silky needles; it melts at 240° C., is converted into benzoic acid and benzonitrile, a red oil smelling of Tonka beans.

ON AURINE.*

By R. S. DALE, B.A., and C. SCHORLEMMER, F.R.S.

In the July number of the *Journal of the Chemical Society* we have published a short note on "Aurine," a colouring matter discovered by Kolbe and Schmitt, in 1861, and which is now found in commerce under the name of aurine, yellow coralline, or rosolic acid. The commercial product which is obtained by heating phenol with oxalic and sulphuric acids, is a mixture of different bodies, from which we have isolated the pure colouring matter by dissolving the crude aurine in alcohol, and treating this solution with ammonia. A crystalline precipitate, a compound of aurine with ammonia, separated out, whilst the other bodies present remained in solution. The ammonia compound was washed with alcohol by means of Bunsen's filter pump, and decomposed by dilute acetic acid. The

* Read before the Manchester Literary and Philosophical Society October 31, 1871.

aurine thus obtained was further purified by repeated crystallisation from strong acetic acid. It crystallised in rhombic needles or prisms, the colour of which varies according to the concentration of the acid, and as it appears also, according to the purity of the substance. We have obtained it in needles having the colour of chromic acid, and a brilliant diamond lustre, or in darker red crystals of varying shades, with a steel-blue, greenish-blue, or splendid beetle-green reflection. We have analysed these different specimens, partly dried at 100° and partly at higher temperatures, and although samples of the same preparation gave very agreeing results, those of different preparations varied very much in their composition. The reason of this is, that aurine retains most obstinately water and acetic acid, a fact which has also been observed by Fresenius,* who has lately published a note on the same subject.

From concentrated hydrochloric acid aurine crystallises in fine hair-like red needles, which, dried at 110°, contain a large quantity of hydrochloric acid. We tried to obtain the pure compound by precipitating a dilute alkaline with dilute hydrochloric acid, and washing the precipitate by Bunsen's filter pump, but also this product contains hydrochloric acid, which was only given off above 110°.

By spontaneous evaporation of an alcoholic solution, aurine is obtained in dull red crystals, with a green metallic lustre. Dried at 110° this body contains no alcohol, but still retains a large quantity of water, which only escapes between 140° to 180°, the crystals not changing their appearance at all, and they may be heated up to 200° without any further alteration, which fact does not agree with Fresenius's observation, that aurine crystallised from alcohol or acetic acid melts at 156°. The analysis of this body, dried at 200°, which we believe to be pure aurine, gave numbers closely agreeing with the formula $C_{20}H_{14}O_3$, and the mode of its formation may, if this formula is correct, be expressed by the equation

$$3C_6H_6O + C_2O_2 = C_{20}H_{14}O_3 + 2H_2O.$$

The substance dried at 110° lost at 180° 5·4 per cent of water corresponding to the formula $C_{20}H_{14}O_3 + H_2O$.† Caro and Wanklyn obtained by the action of nitrous acid on rosaniline a body, which they believe to be identical with aurine, and to which they assign, from the mode of formation, the composition $C_{20}H_{16}O_3$,‡ differing from our formula only by two atoms of hydrogen.

Nascent hydrogen converts aurine into colourless *leuco-aurine*, $C_{20}H_{18}O_3$. This reduction may be effected by heating it in an alkaline solution with zinc dust, but at the same time a dark resinous body is formed, from which the leuco-aurine cannot be easily freed. Better results are obtained by acting with zinc dust on a solution of aurine in strong acetic acid. Leuco-aurine crystallises from acetic acid or alcohol in compact colourless prisms.

A body resembling leuco-aurine is contained in crude aurine; we have not as yet obtained it in a pure state. It differs from leuco-aurine, however, by yielding a purple solution on adding potassium ferricyanide to its alkaline solution, whilst leuco-aurine under the same conditions is oxidised to aurine, which dissolves in alkalies with a magenta red colour.

By passing sulphur dioxide into a hot alcoholic solution of aurine, brick-red crystals separate, being a compound of aurine with sulphur dioxide. They do not smell of sulphur dioxide, undergo no change when exposed to the air, and are only decomposed at a temperature above 100°, when they split up into sulphur dioxide and aurine.

On mixing an alcoholic solution of aurine with a solution of a bisulphide of the alkaline metals, the liquid becomes colourless, a compound of aurine with the bisulphide being formed, which by spontaneous evaporation of the solution, is obtained in splendid colourless needles. These compounds are decomposed by acids as well as alkalies. We have not as yet analysed these different compounds, but intend to do so, hoping thus to find the correct formula for this remarkable compound.

By heating aurine with alcoholic ammonia in closed vessels to 110°, the so-called red coralline is obtained, a body which has great resemblance to the yellow aurine, but dyes a redder shade. This compound we have also obtained in fine crystals.

* *Journ. f. Prakt. Chem.*, No 10, 1871.

† Fresenius analysed aurine which was crystallised from alcohol and dried at 100°. His numbers agree exactly with the formula $C_{20}H_{14}O_3 + 2\frac{1}{2}H_2O$.

‡ *Proc. Roy. Soc.*, xv., 210.

ON THE

SEPARATION OF THE OXIDE OF IRON FROM OXIDE OF URANIUM,

AND THE

ESTIMATION OF PHOSPHORIC ACID BY MEANS OF URANIUM.

By H. RHEINECK.

ACCORDING to Arendt and Knop (see the fourth German edition of Fresenius's "Quantitative Analysis," p. 421), a precipitate of oxide of iron containing uranium is obtained when a mixed solution of the acetates of these two oxides is boiled. In order to separate, in this manner, the iron from the uranium, the nitric acid solution of the two oxides was first as nearly as possible neutralised with carbonate of soda, next converted into acetates by the addition of acetate of soda, and thereupon diluted with water to fifty times the weight of the oxides present. Since I observed that when a solution of acetate of uranium is boiled over an open fire there is a great chance that oxide of uranium is deposited on the sides of the vessel wherein the liquid is contained, I heat the vessel on a water-bath. A small quantity of the precipitate thus formed, having been tested directly after the precipitate was formed, was found to be free from uranium; but the bulk of the precipitate having been left standing for a length of time, without having been first thoroughly well washed, exhibited a crystalline admixture, which could only be removed by being heated with a large quantity of water, care being taken to heat on the water-bath, and the oxide of iron was then found to be quite free from uranium. The small crystals alluded to, having been separated from oxide of iron adhering thereto, were found to possess the peculiar colour of salts of oxide of uranium and a tetrahedrical shape. I considered it of some interest to make a further investigation of these crystals.

When to any salt of oxide of uranium in aqueous solution acetate of soda is added, the result is, that either at once, or in more dilute solutions after some time, a crystalline compound is precipitated. This precipitate exhibits the following properties:—Shining, hard, small crystals, chiefly octahedra. This body is not acted upon by either air or light, not even in aqueous solution under the direct action of sunlight. 1 part of this substance requires 25 parts of water at the ordinary temperature for solution, and the substance may be heated to 130° without undergoing any change. When heated in contact with air to moderate red heat the material burns off, the acetic acid being destroyed, and there is left yellow oxide, of which, by two different experiments, I obtained 68·68 and 67·21 per cent. By heating with sulphuric acid in excess, and continuing the heating to incipient red heat, so as to drive off all the excess of sulphuric, and also the acetic acid completely, it yielded a residue of 93·82 per cent. Phosphate of soda, having been first acidified with acetic acid, yielded a precipitate which, after ignition, amounted to 78·15 per cent. Since there is no water of crystallisation, this loss by ignition represents acetic acid ($C_4H_3O_3$),

and gives, when compared with the phosphoric acid precipitate, a clue to the composition of the crystalline substance. The quotients $\frac{100-68\cdot68}{C_4H_3O_3}$ and $\frac{100-67\cdot21}{C_4H_3O_3} = \frac{31\cdot32}{59}$, and. $\frac{32\cdot79}{59} = 0\,614$ and $0\cdot643$ stand to the quotients $\frac{78\cdot15}{(U_2O_2)PO_7} = \frac{78\cdot15}{359} = 0\cdot2176$, about in the relation as three to one; therefore there are upon 3 equivalents of acetic acid 2 equivalents of oxide of uranium, the rest being soda. The formula $(U_2O_2)_2Na,3C_4H_3O_3=472$, when is taken U = 60, requires 67·59 per cent of residue after ignition, also 94·70 per cent of sulphate of uranium, $(U_2O_2)_2Na,3SO_4$, and lastly 76·05 per cent of pyrophosphate of oxide of uranium. Consequently the salt hereinbefore alluded to is the same as that which Wertheim* described as being obtained by mixing acetic acid combinations of uranium and soda in aqueous solution. In order to apply this salt to the volumetrical estimation of phosphoric acid, I proceed just in the same manner as has been described by Stohmann†; but the preparation of the uranium liquid can be more simply done, while, moreover, a previous test-titration by means of phosphate of soda can be dispensed with. The solution of the salt (to be weighed in the state either of very small crystals or ground up) may be made at the ordinary temperature. I prefer to take of the double salt $\frac{47\cdot2}{2}$ grm. to 1 litre of water, so that it is a normal solution at $\frac{1}{10}$th; that is to say, 1 c.c. indicates 0·00005 grm.-equivalent, or 0·00355 grm. of PO_5. Such a solution does not throw down crystals (viz., of the double salt), and the solution might be even more diluted. While experimenting, I purposely employed upon 10 c.c. $\frac{1}{10}$th of normal phosphate of soda solution, always 2 or $3\frac{1}{10}$ c.c. more than 20 c.c., in order to call forth faintly the reaction with ferrocyanide of potassium. In order to make this reaction appear, it is not necessary to add a certain excess of uranium, and therefore I finish off the experiment by the addition of the phosphoric acid-containing fluid until the reaction with ferrocyanide just ceases to be perceptible; and if, for that purpose, a normal solution of phosphate of soda at $\frac{1}{10}$th be taken instead of the phosphoric acid solution to be tested, it is only required to subtract the number of c.c. employed of that solution from the number of c.c. employed of the uranium solution. The result thus obtained will be undoubtedly nearer to the true relation existing between phosphoric acid and oxide of uranium than when the reaction with ferrocyanide is simply relied on.

In order, however, to determine more accurately the relation existing between the weight of the uranium double salt and phosphoric acid when the former substance is used for the volumetrical determination of the latter, I prepared solutions of the same strength—that is to say, such solutions which by equal bulk contain equal quantities by weight—the experiment being so conducted as to render me independent of balance, measuring vessels, and the influence of varying temperature. The solutions contained 2 grms. of substance for 100 c.c. Ten c.c. of phosphate of soda solution were acidulated with acetic acid and warmed. After the addition of 15 c.c. of the solution of the uranium double salt a very small drop of the fluid gave, on being tested with a very small drop of ferrocyanide solution, a deep brown colouration (the drops of ferrocyanide solution should be kept ready at hand on a small porcelain slab). No reaction was perceptible after the addition of 2 c.c. of the first-named solution; a rather strong reaction was observed after a further addition of 2 c.c. of the second solution; again, after addition of 0·5 c.c. of the first solution a weak reaction, and upon the addition of 0·2 c.c. more of the same solution a very weak reaction was observed; lastly, after the addition of 0·2 c.c. of the same solution all reaction with the ferrocyanide ceased, but 1 drop = $\frac{1}{10}$th c.c. more of the uranium solution brought about the reaction faintly again. Accordingly, upon 12·9 c.c. of the first solution 17 c.c. of the second have been applied—that is to say, upon 129 parts by weight of phosphate of soda 170 parts by weight of the double acetate of uranium and soda—taking the equivalent of phosphate of soda, Na_2H,PO_8+24HO, at 359, and the formula of reaction—

$$Na_2HPO_8+(U_2O_2)_2Na.3C_4H_3O_4 = 3C_4H_3NaO_4+(U_2O_2)_2HPO_8 \quad 129 : 170 : 473\cdot1.$$

The quantity of the double salt to be used for the volumetric estimation of phosphoric acid is the number 473; but when 472 (U = 60) is the right number, there can only be a very small error, equal, in this instance, and under the premises just stated, to 0·233 per cent of the uranium taken in excess; and since the percentage of phosphoric acid obtained in excess is precisely the same, it is either in the calculation or in the quantity of the solution of the uranium that the required correction can be made.

* *Journ. für Prakt. Chem.*, vol. xxix., p. 216.
† Fresenius, *Zeitschr. für Anal. Chem.*, Jahrgang vii.

ON THE

ATOMIC WEIGHTS OF COBALT AND NICKEL.

By RICHARD H. LEA.

THE atomic weights of cobalt and nickel have long been subjects of controversy, but though much time and labour have been spent upon them, the results arrived at are not as satisfactory as could be desired.

Under these circumstances Professor Gibbs suggested to me a new investigation of the subject. Before giving an account of my own methods and results, I will state briefly those of other chemists. Rothhoff,* in 1826, first endeavoured to ascertain the atomic weights of cobalt and nickel. He determined the amount of chlorine in the respective chlorides by means of silver, and, and from a single analysis of each chloride, obtained for cobalt the equivalent 29·55, and for nickel the equivalent 29·60. As the methods of separating the two metals were at that time imperfect, and as but a single analysis was made in each case, Rothhoff's results can hardly be considered as deserving of confidence.

Erdmann† and Marchand, in 1852, determined the atomic weight of nickel by reducing nickelous oxide in hydrogen. Their results varied between 29·1 and 29·3, and they regarded the lower number as more probably correct. It seems at least possible that the nickel they employed contained traces of cobalt. The subject was again taken up by Schneider‡ in 1857. Pure metallic cobalt was prepared by igniting chloride of purpureo-cobalt in hydrogen. The metal was then dissolved in chlorhydric acid and precipitated by sodic carbonate. The carbonate was washed, and then digested with oxalic acid, the resulting oxalate again washed, burnt in a current of oxygen and the oxide reduced by hydrogen. In other portions of the oxalate the carbon was determined by combustion with cupric oxide.

The following tables gives a summary of the results obtained:—

	Oxalate taken.	Cobalt found. Per cent.	Carbon found. Per cent.	Equivalent Co
1.	1·6355 2·3045	32·552	13·024	29·993
2.	1·1070 1·9010	32·619	13·041	30·015
3.	2·3090 4·0580	32·528	13·005	30·014
4.	3·0070 5·3500	52·523	13·014	29·989
			Mean,	30·003

* *Poggendorff's Annalen*, vol. viii., pp. 184-5.
† *Annalen der Pharmacie*, vol. lxxxii., p. 76.
‡ *Poggendorff's Annalen*, vol. ci., p. 387.

Determinations of the atomic weights of cobalt and nickel were also made in 1857 by Marignac.* Cobaltous sulphate was purified by repeated crystallisation and a weighed quantity of the salt heated so as to expel the acid. The resulting oxide was then heated with a known weight of silicate of lead so as to expel the excess of oxygen over and above that required to form cobaltous oxide, CoO. The results obtained varied between 29·32 and 29·38.

Crystallised cobaltous chloride dried at 100° was found to retain 1 atom of water. Three determinations of the chlorine in this salt by means of silver gave for the atomic weight of cobalt 29·42 to 29·51. Anhydrous cobaltous chloride was obtained by heating the crystallised salt with sal-ammoniac, in a current of dry chlorine or dry chlorhydric acid gas. The salt almost always, however, left a slight residue insoluble in water. Five analyses of the anhydrous salt gave results varying from 29·36 to 29·42.

In 1859 Dumas† turned his attention to the subject. Perfectly pure metallic cobalt was dissolved in nitro-muriatic acid, the solution evaporated to dryness with frequent additions of chlorhydric acid, and the cobaltous chloride submitted to a red heat. In a second preparation from a different sample of metal the chloride was dried *in vacuo*. In this manner the following results were obtained:—

	$CoCl_2$.	Silver.	Equivalent.
1.	2·3520	3·9035	29·57
2.	4·2100	6·9900	29·54
3.	3·5920	5·9600	29·59
4.	2·4920	4·1405	29·50
5.	4·2295	7·0255	29·51

The mean of these five determinations is 29·54. In all cases the chloride was dissolved in boiling water and the solution allowed to cool before precipitating with $AgNO_3$. The argentic chloride was reduced in hydrogen. The method employed for the preparation of pure cobalt is not stated.

Russell‡ determined the atomic weights of cobalt and nickel in 1863. Pure metallic cobalt was prepared by igniting chloride of purpureo-cobalt in hydrogen. The metal was dissolved in nitric acid and the solution evaporated and strongly heated. The black oxide obtained was ignited in a current of carbonic dioxide, by which it was converted into light brown cobaltous oxide, CoO, which was then reduced by pure hydrogen. Omitting two trial experiments, the results obtained were as follows:—

	CoO.	Cobalt.	Cobalt pr. ct.
First sample, 1.	2.1211	1·6670	78·591
2.	2·0241	1·5907	78·588
3.	2·1226	1·6673	78·550
4.	1·9947	1·5678	78·598
5.	3·0628	2·4078	78·614
		Mean,	78·588
First specimen twice purified—			
1.	2·1167	1·6638	78·603
2.	1·7717	1·3924	78·591
3.	1·7852	1·4030	78·591
		Mean,	78·595
First specimen three times purified—			
1.	1·6878	1·3264	78·588
2.	2·2076	1·7350	78·592
		Mean,	78·590
Second specimen—			
1.	2·6851	2·1104	78·597
2.	2·1461	1·6868	78·598
		Mean,	78·597
Third specimen—			
1.	3·4038	2·6752	78·595
2.	2·2778	1·7901	78·589
3.	2·1837	1·7163	78·596
		Mean,	78·593

* *Bibliothèque Universelle de Geneve*, Nouvelle Series, vol. i., p. 373.
† *Ann. de Chemie et de Physique*. 3rd series, vol. lv., p. 148.
‡ *Annalen der Pharmacie*, vol. cxxvi., pp. 322-336.

The mean of all the results is 78·5926, from which we find for the equivalent of cobalt on the old system 29·37.

In 1866 the subject was taken up by Sommaruga,* who determined the amount of metallic cobalt in chloride of purpureo-cobalt by reduction in a bulb tube with hydrogen. His results were as follows:—

	Salt taken.	Cobalt found.	Equivalent.
1.	0·6656	0·1588	30·002
2.	1·0918	0·2600	29·929
3.	0·9058	0·2160	29·982
4.	1·5895	0·3785	29·926
5.	2·9167	0·6957	29·992
6.	1·8390	0·4378	29·916
7.	2·5010	0·5968	30·009
		Mean,	29·965

Winkler†, in 1867, determined the atomic weight of cobalt by heating a known weight of the metal with a perfectly neutral solution of double chloride of gold and sodium. The cobalt was obtained by the reduction of chloride of purpureo-cobalt.

	Salt taken.	Gold found.	Equivalent of Co(Au=196).
1.	0·5890	1·3045	29·497
2.	0·3147	0·6981	29·451
3.	0·5829	1·2913	29·492
4.	0·5111	1·1312	29·518
5.	0·5821	1·2848	29·522
		Mean,	29·496

Finally, in 1869, Weselsky‡ made a new determination of the atomic weight of cobalt by finding the quantity of metallic cobalt in weighed quantities of cobalti-cyanide of aniline-ammonium and of ammonium. The results were as follows:—

	Cobalt salt.	Cobalt found.	Equivalent
1.	0·8529 gr.	0·1010	29·44
2.	0·6112 ,,	0·0723	29·38
3.	0·7140 ,,	0·0850	29·59
4.	0·9420 ,,	0·1120	29·54
1.	0·7575 ,,	0·1160	29·46
2.	0·5143 ,,	0·1130	29·55
		Mean,	29·48

The first four analyses were made with the aniline, the last two with the ammonium salt. These are the only determinations of the atomic weight of cobalt which I have been able to find, and I will therefore pass to my own analyses.

Commercial cobaltic oxide was treated in a large porcelain crucible with enough strong sulphuric acid to make it into a stiff paste. The crucible was then placed in a muffle furnace and heated for some time, at first gently and afterwards to low redness. The sulphate obtained was dissolved, filtered, and submitted for some time to a current of sulphydric acid gas, by which copper, arsenic, &c., were removed. The filtrate was treated with chlorine water to peroxidise the iron present and then allowed to stand for forty-eight hours in contact with baric carbonate, the whole being frequently and thoroughly stirred. In this manner iron and manganese were almost wholly removed. The filtrate was then treated with a large excess of baric carbonate, and cyanhydric acid gas passed into the liquid until the whole of the cobalt was converted into cobalti-cyanide of barium, $Co_2Cy_{12}Ba_3$. The solution of this salt was then boiled with mercuric oxide to separate the nickel present, as $NiCy_4Ba$, as well as traces of iron and manganese. The mercury was then removed from the filtrate by sulphydric acid gas, and the solution of cobalti-cyanide barium regarded as chemically pure. The methods which I adopted to determine the atomic weight of cobalt do not differ in principle from those of Weselsky and Sommaruga. I first formed cobalti-cyanides of

* *Sitzungsberichte der Wiener Akad.*, vol. liv, p. 50.
† *Zeitschrift für Annal. Chemie*, 1867, p. 18.
‡ *Berichte der Deutschen Chem. Gesellschaft*, 1870.

alkaloids having high atomic weights and forming highly crystalline and perfectly definite double cyanides. I then determined the water of crystallisation in these salts directly, and afterwards the percentage of cobalt in each. This last was effected by first carefully heating the salt in a platinum crucible by means of a ring-burner, and afterwards burning off the carbon first in air and then in oxygen. Finally the cobalt was reduced to metal by a current of pure hydrogen, and weighed. In this manner but two weighings were necessary. In another series of experiments I determined the amount of metallic cobalt in weighed quantities of chloride of purpureo-cobalt by igniting the salt in a current of pure hydrogen gas. To effect the reduction without loss, I employed an arrangement due to Dr. Gibbs, and consisting of a small thin disk of porous earthenware. The chloride of purpureo-cobalt was placed in a porcelain crucible and the disk of earthenware supported above it by the walls of the crucible. The hydrogen was introduced by a tube passing into the bored cover, and the crucible was then carefully heated from above. In this manner the gas diffused through the porous septum, which in turn served to prevent the escape of any particles of solid substance. The reduction was absolutely complete, and the metal did not oxidise after slowly cooling in an atmosphere of hydrogen. In the analyses made in this manner, also, but two weighings were necessary.

In my first series of experiments I employed only the cobalti-cyanides of brucine and strychnine, the corresponding salts of morphine, narcotine, chinine, and cinchonine having been found difficult to prepare in a state of purity by re-crystallisation. The brucine and strychnine salts were prepared by decomposing the sulphates of these bases with cobalti-cyanide of barium, and repeatedly re-crystallising the salts formed. The brucine salt crystallised in beautiful white, barb-shaped crystals with a high lustre. It was but slightly soluble in cold water, and crystallised with remarkable facility. The strychnine salt was in beautiful, nearly colourless needles, and like the brucine salt crystallised almost completely from its solution on cooling. Six analyses were made with each of these salts.

Of the strychnine salt—

0·7084 gr. dried at 115° C. lost 0·0392 gr. of water = 5·53 per cent. The formula,

$$Co_2Cy_{12}(C_{21}H_{22}N_2O_2)_6H_6+8OH_2,$$

equires 5·57 per cent water of crystallisation.

The following are the results of my determinations of the amount of cobalt in this salt:—

No.	Salt taken. Gr.	Cobalt. Gr.	Cobalt. p. c.	At. weight.
1.	0·4255	0·0195	4·5830	59·22
2.	0·4025	0·0185	4·5960	59·36
3.	0·3733	0·0170	4·5540	58·83
4.	0·4535	0·0207	4·5640	58·96
5.	0·2753	0·0126	4·5770	59·14
6.	0·1429	0·0065	4·5490	58·76
		Mean,	4·5705	59·05

The probable error of the mean is ±0·012, and the atomic weight of cobalt 59·05, with a probable error of ±0·156. In the case of the brucine salt, three determinations of the water of crystallisation were made.

Gr.	Gr.		
0·4097 gave	0·0465 water at	117° C.	= 11·35 per cent.
0·3951 ,,	0·0453 ,,	119° ,,	= 11·46 ,,
0·6653 ,,	0·0752 ,,	128° ,,	= 11·30 ,,

The mean of these three determinations is 11·37 per cent.

The formula, $Co_2Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6+20OH_2$, requires 11·39 per cent water of crystallisation.

The results of my determinations of the amount of metal in this salt are as follows:—

	Salt taken. Gr.	Cobalt. Gr.	Cobalt, p. c.	At. weight.
1.	0·4097	0·0154	3·7590	59·41
2.	0·3951	0·0147	3·7200	58·76
3.	0·5456	0·0204	3·7390	59·08
4.	0·4402	0·0165	3·7480	59·22
5.	0·4644	0·0174	3·7470	59·21
6.	0·4027	0·0151	3·7470	59·24
		Mean,	3·7437	59·15

The probable error of the mean is here ±0·0088, and the atomic weight of cobalt 59·15, with a probable error of ±0·146.

The method of analysing the chloride of purpureo-cobalt has already been described. The results of my analyses are as follows:—

No.	Salt taken. Gr.	Cobalt. Gr.	Cobalt, p. c.	At. weight.
1.	0·9472	0·2233	23·5750	59·07
2.	0·8903	0·2100	23·5870	59·11
3.	0·6084	0·1435	23·5860	59·11
4.	0·6561	0·1547	23·5790	59·08
5.	0·6988	0·1647	23·5690	59·05
6.	0·7010	0·1653	23·5810	59·09
		Mean,	23·5795	59·09

The probable error of the mean is here ±0·004, and the calculated atomic weight 59·09 with a probable error of ±0·0146.

The mean of my eighteen determinations of the atomic weight of cobalt is 59·10. For the sake of comparison I give here the results obtained by other observers, in tabular form, reduced to the modern scale of atomic weights:—

Rothhoff,	59·10	Russell,	58·74
Schneider,	60·00	Sommaruga,	59·93
Marignac,	58·84 to 59·02 58·72 to 28·84	Winkler,	58·99
		Weselsky,	58·96
Dumas,	59·08	Lee,	59·10

Nickel.—The atomic weight of nickel was also first determined by Rothhoff* in 1826, by determining the amount of chlorine in a weighed quantity of nickelous chloride. A single experiment gave for the equivalent 29·60, a number which is probably too high, in consequence of the imperfection of the processes known at that time for the separation of nickel from cobalt. Erdmann and Marchand took up the subject in 1852†. Nickelous oxide prepared by various processes was reduced in a current of hydrogen and the metal weighed. No data are given, but the authors state that their results varied between 29·1 and 29·3, and that they consider the lower number more probably correct.

Schneider‡, in 1857, also determined the atomic weight of nickel. Pure nickelous oxalate was burnt with cupric oxide to determine the oxalic acid, while the amount of metallic nickel was obtained by reducing the oxide with pure hydrogen. In this manner Schneider obtained as the mean of four analyses the number 29·02.

Marignac,‖ in 1857, determined the atomic weight of nickel by methods precisely similar to those employed by him in the case of cobalt already cited. His analyses of the sulphate of nickel gave results varying from 29·2 to 29·5, while those of the chloride gave results varying between 29·4 and 29·64. Marignac does not give his method of obtaining pure salts of nickel.

The subject was next investigated by Dumas,§ who determined the quantity of chlorine in nickelous chloride, and obtained for the equivalent of nickel as a mean of five analyses the number 29·514. The author does not give the process by which the nickel was obtained free from cobalt.

Russell,¶ took up the subject of the atomic weight of

* *Pogg. Ann.* vol. viii., p. 184.
† *Ann. der Pharmacie*, lxxxii., p. 76.
‡ *Pogg. Ann.*, ci., p. 387.
‖ *Bibliothèque Universelle de Geneve*, Nouvelle Series, vol. i., p. 373.
§ *Ann. de Chemie et de Physique*, 3rd series, vol. lv., p. 148.
¶ *Ann. der Pharmacie*, vol. cxxvi., pp. 322—336.

nickel, together with that of cobalt, in 1863. Pure nickelous oxide was first ignited in a current of carbonic dioxide, and afterward in pure hydrogen. His results were as follows:—

1st specimen, mean of 3 determinations, 100 parts of oxide gave 78·596 Ni.
2nd specimen, mean of 3 determinations, 100 parts of oxide, gave 78·584 Ni.
3rd specimen, mean of 3 determinations, 100 parts of oxide, gave 78·598 Ni.
4th* specimen, mean of 3 determinations, 100 parts of oxide, gave 78·592 Ni.

The mean of all the determinations gave for the quantity of nickel in 100 parts of the oxide 78·5925, and for the atomic weight of nickel 58·74.

In 1866, Sommaruga† determined the atomic weight of nickel by ascertaining the quantity of sulphuric acid in pure crystallised double sulphate of nickel and potassium. The mean of six analyses gave for the equivalent of nickel the number 29·013, with a probable error of ±3·079.

Winkler‡, in 1867, employed the method of reduction already described. The mean of four analyses gave for the equivalent 29·527, with a probable error of ±0·056.

With these preliminary statements I pass to an account of my own methods and results. Metallic nickel of commerce was dissolved in nitro-sulphuric acid, and the nitric acid expelled by heat. The sulphate was then dissolved in water and the traces of copper and arsenic removed by a long-continued current of sulphydric acid gas. The iron in the filtrate was then oxidised by means of bromine, and precipitated by agitation with $BaCO_3$. The cobalt was removed by potassic nitrite and the nickelous sulphate then converted into nickel-cyanide of potassium, which was re-crystallised. This salt contained only a trace of cobalt after four crystallisations. To determine the atomic weight of nickel I adopted the method already employed to determine that of cobalt. I first formed the double cyanides of nickel with brucine and strychnine, and then determined, first the quantity of water in each of these salts, and afterward the percentage of metallic nickel. This last determination was effected by first carefully heating the salt in a platinum crucible, employing the ring-burner of Dr. Gibbs so as to apply the heat at the rim of the crucible first, and afterward in successive zones until the bottom of the crucible was reached. The remaining carbon was then burned off in a current of pure oxygen, and the oxide of nickel finally reduced by igniting it in carefully purified hydrogen.

The double cyanides of nickel, brucine, and strychnine were prepared by double decomposition, the salts being but slightly soluble in cold water. They were then repeatedly re-crystallised, and when tested by the spectroscope were found to be absolutely free from potassium. All of these salts crystallised in very pale yellow needles.

My analyses of the brucine salt led to the following results:—

0·4496 gr. dried at 120° C. lost 0·0258 gr. ΘH_2 = 5.738 per cent water.

The formula $Ni_3Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6+10\Theta H_2$, requires 5·929 per cent.

No.	Salt taken.	Nickel.	Nickel, p. c.	At. weight.
1.	0·3966	0·02270	5·7240	57·92
2.	0·5638	0·03230	5·7290	57·98
3.	0·4000	0·02300	5·7500	58·20
4.	0·3131	0·01795	5·7330	58·02
5.	0·4412	0·02520	5·7120	57·79
6.	0·4346	0·02490	5·7290	57·98
		Mean,	5·7295	57·98

The probable error of the mean percentage of nickel is ±0·008 and the atomic weight of nickel 57·98, with a probable error of ±0·089.

Six analyses of the strychnine salt were then made.

0·3399 gr. dried at 112° C. lost 0·0178 gr. water = 5·24 per cent.

The formula $Ni_3Cy_{12}(C_{21}H_{22}N_2O_2)_6H_6+8\Theta H_2$, requires 5·45 per cent.

No.	Salt taken.	Nickel.	Nickel, p. c.	At. weight.
1.	0·5358	0·0354	6·607	58·15
2.	0·5489	0·0363	6·613	58·21
3.	0·3551	0·0234	6·589	57·98
4.	0·4495	0·0297	6·607	58·15
5.	0·2530	0·0166	6·561	57·72
6.	0·1956	0·0129	6·595	58·04
		Mean,	6·595	58·04

The probable error of the mean percentage of nickel is ±0·013, and the atomic weight 58·038, with a probable error of ±0·119.

The mean of all my determinations of the atomic weight of nickel is 58 01. The following table gives all the determinations made:—

Rothhoff,	59·20	Dumas,	59·028
Erdmann and Marchand,	58·20 to 58·60	Russell,	58·740
		Sommaruga,	58·026
Schneider,	58·04	Winkler,	59·054
Marignac,	58·40 to 95	Lee,	58·010

In conclusion, my thanks are due to Dr. Gibbs for the selection of the subject of my work, and for his advice during the course of my investigation.—*American Journal of Science.*

* Second purification.
† *Sitzungsberichte der Weinen Akad.*, vol. liv., p. 50.
‡ *Zeitschrift für Analyt. Chemie*, 1867, p. 28.

ON THE

DETERMINATION OF NITROUS ACID,

WITH SPECIAL REFERENCE TO THE

MANUFACTURE OF OIL OF VITRIOL.*

By W. CROWDER.

In the course of my daily occupation I have had occasion to make some observations at the chambers on the absorption of nitrous acid, and being in want of some rapid but accurate method for determining the quantity in the vitriol from the columns and denitrators, I have endeavoured to devise a good process for accomplishing this object.

I cannot find that there are more than one or two persons on the Tyne who use any quantitative process at all, most managers depending upon the rule-of-thumb method of adding water and judging the amount of absorption by the quantity of gas evolved on admixture.

The only methods with which I am acquainted are the "chloride of lime" and the "urea" processes. The chloride of lime process is in use occasionally, but I cannot find that any attempt has been made to express in terms of nitrous acid or nitrate of soda the percentage of nitrous acid present.

The directions for performing this analysis in Richardson and Ronalds are as follows:—

"A small tube, measuring 20 cubic centimetres, is filled with chloride of soda of 100 Gay-Lussac; its contents are poured into a phial which contains about two-thirds of a pint of distilled water.

"Another glass instrument, measuring 20 cubic centimetres, divided into 200 parts, is filled with nitrous sulphuric acid to be tested, and the acid is gradually poured from it into the phial which contains the solution of chloride of soda until, on adding a few drops of a solution of indigo in sulphuric acid, the blue colour is no longer destroyed. If 17 or 20 parts only have been used, 10 pints of the acid tested will cause a saving of 1 lb. of nitre. The more acid required to destroy the colour of the indigo the less nitrous acid it contains."

I have not used this method, but I hear the results are pretty constant.

* Read before the Newcastle-upon-Tyne Chemical Society.

"Hart's process," by nitrate of urea, is founded upon the fact that urea, when brought in contact with nitrous acid, is instantly decomposed into carbonic acid and nitrogen, thus:—

$$\text{Urea } C_2N_2H_4O_2+2NO_3=2CO_2+4N+4HO,$$

and upon the fact that nitrous acid decomposes iodide of potassium with liberation of free iodine.

If, therefore, a solution of a known quantity of urea be taken and nitrous vitriol dropped into it, so long as any urea remains undecomposed no reaction of nitrous acid is manifested, but so soon as all the urea is decomposed the nitrous acid produces the well-known reaction upon iodide of potassium, liberates iodine, and in the presence of a solution of starch gives at once the characteristic blue colour of iodide of starch.

The practical part of the process is as follows:—

Twenty grains of nitrate of urea are dissolved in a few ounces of water and the fluid raised to the boil. The nitrous vitriol to be examined is filled into a burette. The solution of urea is removed from the lamp and the nitrous vitriol dropped into it. Brisk effervescence takes place from the evolution of carbonic acid and nitrogen gases; a drop of the fluid is from time to time taken out and added to some drops of solution of iodide of potassium and starch spotted on a white plate. At first the iodine and starch fluid manifest no reaction, but as fresh additions of nitrous vitriol are made to the solution of urea a point is arrived at when the nitrous acid has decomposed all the urea, any further quantity of nitrous acid now remains in the fluid, and a drop of the fluid now added to the spots of iodide and starch developes the colour and indicates the conclusion of the reaction.

The number of graduations of nitrous sulphuric acid used in decomposing the 20 grains of nitrate of urea, indicates at once, by a simple calculation, the quantity of nitrous acid present.

The calculation is based on the fact, that for every 20 grs. of nitrate of urea there would be required 12·35 grs. of nitrous acid, which is equivalent to 27·64 grs. of nitrate of soda.

I have made some enquiries among chemists here, but I cannot find anyone who has succeeded in making it a practical process.

I have tried it myself on the same sample of nitrous vitriol, four times over, but I cannot say that I have been successful, as will be seen by the following results:—

Grs. of nitrate of urea required.	Grs. of nitrous sulphuric acid.
20	334·90
20	190·30
20	187·80
20	327·20

It is possible that I may not have complied with some necessary condition, but I think I have followed the process exactly as laid down in Muspratt's "Chemistry," vol. ii., p. 1040.

There appears to me to be a defect in the process, inasmuch as the reaction is ordered to be effected at a boiling-heat.

Now, on adding nitrous vitriol to a boiling solution of nitrate of urea, a very tumultuous effervescence takes place, and, I think, an error of loss of nitrous acid occurs, and from some cause, which I confess I cannot clearly understand, the reaction of iodine does not manifest itself so soon in some cases as in others, the result being that you cannot hit the mark on two occasions successively. There is a further objection, that the heating of the fluid requires time, and where many samples are to be tested, this becomes an object of some importance.

To obviate these difficulties, I have contrived a plan founded upon this reaction of nitrous acid on urea, which is exceedingly simple and gives very constant results.

I have already shown that in the decomposition of urea by nitrous acid there are formed 2 eqs. of carbonic acid, 4 eqs. of nitrogen, and 14 eqs. of water. The carbonic acid and nitrogen escape with effervescence, and by suitable appliances may be weighed; the loss of weight will express, by a simple calculation, the quantity of nitrous acid present.

The apparatus required is an ordinary carbonic acid apparatus, in which the moisture is arrested by sulphuric acid, and by which the acid to be tested can be run into the solution of nitrate of urea in a very gentle stream. Such an instrument is described in Fresenius as a Geissler's carbonic acid apparatus. The one I have been using is on the same principle, but slightly modified in details.

The operations are as follows:—

The bottle of the instrument is half filled with water, containing about 20 grs. of urea or 30 grs. nitrate of urea in solution. The instrument is now weighed; the acid tube is filled with the nitrous vitriol, to be tested and weighed again; the difference is the quantity of substance taken.

The tap containing the nitrous vitriol is turned on, and a slow stream of acid falls down through the solution of nitrate of urea to the bottom of the vessel. In the course of a few minutes the acid tube has become empty, the apparatus is shaken to cause complete admixture, and after the violent effervescence which at first takes place is over, the instrument is heated to about 200° to separate all the dissolved gas.

When cold, it is sucked through to remove the gas remaining in the apparatus and weighed.

The difference of weight before and after the operation indicates the quantity of carbonic acid and nitrogen liberated.

The quantity of nitrous vitriol taken is about 300 grs.

The calculation is as follows:—

$$C_2N_2H_4O_2+2NO_3=2CO_2+4N+4HO;$$

Therefore, $2CO_2+4N : 2NO_3$ quantity of CO_2+N found,

Equiv. = 100 : 76 : X : : nitrous acid found.

The results are very constant, as will be seen by the following analysis of samples of nitrous vitriol:—

	Expt. 1.	Expt. 2.
1st trial, by Dr. Hess ..	3·02	2·62
2nd ,, ,, ..	3·08	2·60
3rd ,, W. Crowder ..	3·16	2·63
4th ,, ,, ..	2·35	—

This process seems to me much preferable to the mode of operating with iodide of potassium and starch, and since it is dependent upon a decomposition which is perfectly definite and constant, and the results of which can be most accurately weighed, I am inclined to believe that it is much more to be depended upon than any process in use at present.

I was anxious to institute a comparison between this method and some process dependent upon the oxidation of nitrous acid into hyponitric or nitric acid. Margueritte's process for oxidising proto- into peroxide of iron, suggested itself as one of the best, from the remarkable distinctness with which the point of complete oxidation is indicated; and the rapidity with which it can be performed was a further recommendation.

With this view, I prepared a solution of permanganate of potash in water, of such strength that a burette divided into 1000 grs. measure of water, oxidised a solution containing about 5 grains of iron to peroxide, as in Margueritte's method. Now, to peroxidise protoxide of iron requires the addition of 1 eq. of oxygen to every 2 eqs. of iron.

Therefore, if 2 eqs. Fe : 1 eq. O : : Fe : O.

56 : 8 : : 5 : 0·714.

In the reaction which takes place when permanganate of potash is added to nitrous vitriol, I assume that the whole of the nitro-compounds are there in the form of NO_3. This is in accordance with the experience of those who have paid any attention to the subject, and I

further assume that this NO_3 in the addition of permanganate of potash is converted into nitric and not hyponitric acid.

The above 0·714 gr. of oxygen would, therefore, represent the following quantity of NO_3:—

$$2 \text{ eqs. } O : NO_3 :: O : NO_3$$
$$16 : 38 :: 0{\cdot}714 : 1{\cdot}70$$

The practical process is conducted as follows:—

About 100 to 150 grs. of the nitrous sulphuric acid to be tested is weighed out in a beaker of some 6 oz. capacity. The standard solution of permanganate is poured from the burette, and the number of graduations noted at the point at which the vitriol ceases to decolourise the permanganate.

Care must be taken at the commencement of the operation not to shake the acid and solution, and to keep a little permanganate floating on top of the vitriol, until the vitriol is somewhat diluted, otherwise there is fear of losing a small quantity of nitrous acid by effervescence before it becomes oxidised; this can, however, be very easily managed with ordinary care. The results are perfectly constant, as may be seen by inspection of the tables.

The operation may be varied with advantage for manufacturing purposes by taking a measured quantity of standard solution of permanganate, and dropping into it from a graduated tube, with a pinch-cock, the vitriol to be tested; and it has this great advantage, that it shortens the time, and being done by measure, it involves no trouble or time in weighing.

At the time when I first made these experiments I was not aware that such a plan (although obvious enough) was in use in any laboratory; but on communicating with Mr. Clapham, of the Walker Alkali Works, I found that he had been using this method very successfully for a long time.

From some cause, which I am as yet quite unable to account for, I find that the results obtained by this process are about one-third less than those obtained by the urea method. Whether there is any inaccuracy in the way of calculating and comparing the results I cannot yet discover; but by taking a vitriol containing a known quantity of nitrous acid, as determined by the "urea" process, and standardising the permanganate by that quantity, results are obtained which agree perfectly well with the quantity of NO_3 in other samples as determined by the urea process. It is my intention, as time and opportunity presents itself, to continue the investigation of this very interesting subject of enquiry.

Although a subject of great theoretical interest, it is one which is of considerable practical importance, inasmuch as an accurate method of determining nitrous acid cannot fail to assist a manager in settling many questions of practice about which there is at present great difference of opinion.

Need I further point out the great advantage that the man who works by "rule-of-three" has over the man who works by "rule-of-thumb?"

(To be continued.)

NOTE ON A CUPRIC PHOSPHATE FROM CORNWALL.

By Professor A. H. CHURCH, M.A.

MR. TALLING, of Lostwithiel, forwarded to me some weeks ago specimens of a beautiful mineral, emerald-green to verdigris-green in colour. It occurs on quartz in minute botryoidal forms, and gave on analysis the following percentages:—

Cupric oxide	66·61
Phosphorus pentoxide ..	24·51
Water	8·88
	100·00

From these results and others which I shall take occasion to publish before long, this mineral appears to correspond among the phosphates to Cornwallite among the arseniates. It is a rare mineral, so far as Cornish localities are concerned, though I possess a few specimens obtained from old collections.

It is pseudomalachite, var. A. of Dana, and ehlite of Breithaupt. It formula is evidently $5CuO,P_2O_5,2H_2O$, which may be written $Cu_3P_2O_8+2CuH_2O_2+aq$, thus corresponding to that of Cornwallite as revised by me,* namely—$Cu_3As_2O_8+2CuH_2O_2+aq$. The theoretical percentages demanded by the formula proposed for the Cornish copper phosphate (which is now again being raised, I am told) are these:—

CuO	66·98
P_2O_5	23·92
H_2O	9·10
	100·00

MISCELLANEOUS.

Lectures at the Franklin Institute, 1871-72.—The course of Lectures to be delivered at the Hall of the Franklin Institute, Philadelphia, comprises a series of forty lectures, divided as follows:—"On Physics and Mechanics," by John G. Moore, M.S.; "On General Physics and Acoustics," by Prof. Edwin J. Houston; "On Guns, Gunpowder, and Projectiles," by Lieut. C. E. Dutton; "On the Chemistry of the Earth and of the Vital Process in Animals and Plants," by Prof. Samuel B. Howell, M.D.; "On the History of Alchemy," by William H. Wahl, Ph.D.; "On the Metallurgy of Iron and Steel," by Thomas M. Drown, Ph.D. Besides the lectures enumerated, the Institute has arranged with a number of eminent lecturers for the delivery of a popular course of scientific subjects, for which purpose the Academy of Music has been engaged.

Masses of Meteoric Iron.—At the meeting of the Geological Society held on the 8th inst., there was read a letter from the Embassy at Copenhagen, transmitted by Earl Granville, mentioning that a Swedish scientific expedition, just returned from the coast of Greenland, had brought home a number of masses of meteoric iron found there upon the surface of the ground. These masses varied greatly in size; the largest was said to weigh 25 tons. Mr. David Forbes having recently returned from Stockholm, where he had the opportunity of examining these remarkable masses of native iron, took the opportunity of stating that they had been first discovered last year by the Swedish arctic expedition, which brought back several blocks of considerable size which had been found on the coast of Greenland. The expedition of this year however, has just succeeded in bringing back more than twenty additional specimens, amongst which two were of enormous size. The largest, weighing more than 49,000 Swedish pounds, or about 21 tons English, with a maximum sectional area of about 42 square feet, is now placed in the hall of the Royal Academy of Stockholm; whilst, as a compliment to Denmark, on whose territory they were found, the second largest, weighing 20,000 lbs., or about 9 tons, has been presented to the Museum of Copenhagen. Several of these specimens have been submitted to chemical analysis, which proved them to contain nearly 5 per cent of nickel, with from 1 to 2 per cent of carbon, and to be quite identical in chemical composition with many aërolites of known meteoric origin. When polished and etched by acids, the surface of these masses of metallic iron shows the peculiar figures or markings usually considered characteristic of native iron of meteoric origin. The masses themselves were discovered lying loose on the shore, but immediately resting upon basaltic rocks

* *Journ. Chem. Soc.*, July, 1868.

(probably of Miocene age), in which they appear to have originally been imbedded; and not only have fragments of similar iron been met with in the basalt, but the basalt itself, upon being examined, is found to contain minute particles of metallic iron, identical in chemical composition with that of the large masses themselves, whilst some of the masses of native iron are observed to enclose fragments of the basalt. As the chemical composition and mineralogical character of these masses of native iron are quite different from those of any iron of terrestrial origin, and altogether identical with those of undoubted meteoric iron, Prof. Nordenscksjold regards them as aërolites, and accounts for their occurrence in the basalt by supposing that they proceeded from a shower of meteorites which had fallen down and buried themselves in the molten basalt during an eruption in the Miocene period. Notwithstanding that these masses of metallic iron were found lying on the shore between the ebb and flow of tide, it has been found, upon their removal to Stockholm, that they perish with extraordinary rapidity, breaking up rapidly and falling to a fine powder. Attempts to preserve them by covering them with a coating of varnish have as yet proved unsuccessful; and it is actually proposed to preserve them from destruction by keeping them in a tank of alcohol. Mr. Maskelyne then stated that the British Museum already possessed a specimen of this native iron, and accounted for its rapid destruction on exposure by the absorption of chlorine from terrestrial sources, which brought about the formation of ferrous chloride. This was particularly marked in the case of the great Melbourne meteorite in the British Museum; he had succeeded in protecting this, as well as the Greenland specimen, by coating them externally, after previously heating them gently, with a varnish made of shellac dissolved in nearly absolute alcohol. He considered it probable that a meteoric mass falling with immense velocity might so shatter itself as to cause some of its fragments to enclose fragments of basalt, and even to impregnate the neighbouring mass of basalt with minute particles of the metallic iron: but he considered the question of meteoric origin could only be decided by examining the same mass of basalt at some greater distance from the stones themselves, so as to prove whether the presence of such metallic iron was actually characteristic of the entire mass of the rock.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, October 16, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Thermical Researches on the Energy of the Galvanic Current.—A. Favre.—An instalment of a very excellent and exhaustive essay on this subject, but not suited for useful abstraction; an observation also applying to the following paper:—

Observations on some Points of Spectrum Analysis, and on the Constitution of the Induction Spark.—Lecoq de Boisbaudran.

Researches on the Caloric Coefficients of the Hydro-Electric and Thermo-Electric Currents.—F. M. Raoult.—The main result of the author's researches may be summarised as follows:—The heat evolved by an electric current is independent of the nature of the galvanic element; the caloric coefficient, *Ke*, is the same for all sources of galvanic electricity.

Thermo-Chemical Researches on Ammoniacal Salts.—Dr Berthelot.—The continuation of this very exhaustive memoir (see CHEMICAL NEWS, vol. xxiv., p. 181).

Action of Chlorine upon Various Bodies Belonging to the C_3 Series, and on Substances Isomeric with Trichlorhydrine.—C. Friedel and R. D. Silva.—The authors describe at length a series of experiments, made with the view to prove the isomerism of the compound, $C_3H_5Cl_3$, and next the identity of the two compounds, C_3H_5Cl, derived from aceton and propylen.

Hot Springs and Scalding Sands of the Maronti District of the Island of Ischia.—A. Ranieri.—The author has written a work on this subject, and proposes to utilise the natural (volcanic) heat for the purpose of evaporating sea-water. The Ancients, from a very remote antiquity, were acquainted with the phenomena here alluded to (the island is situated off Naples), and fable attributed the heat to the convulsions of the giant Typhée, killed by lightning by Jupiter, and buried under the rocks of Ischia.

October 23, 1871.

The original papers and memoirs relating to chemistry and collateral sciences published in this number are:—

Thermical Researches on the Electrolysis of the Hydracids.—P. A. Favre.—The second portion of a very lengthy and exhaustive memoir on this subject.

Variable Aspect of the Protuberances and other Remarkable Portions of the Sun's Surface.—Rev. A. Secchi, S.J.—The fifth communication on this subject, this paper being elucidated with woodcuts.

Theory of the Simple Limited Reactions by Inverse Action as Applied to the Metamorphosis of Phosphorus.—G. Lemoine.—A very lengthy algebraico-chemical paper, illustrated with woodcuts.

Industrial Working of a Deposit of Chloride of Potassium near Kalutz (Galicia).—A. Jacot.—It appears that at the locality alluded to there was discovered two years ago a saline deposit, very similar to that of Strassfurth. The kainite of the deposit alluded to consists of:—Sulphate of magnesia, 30·04; chloride of potassium, 29·46; chloride of sodium, 20·67; chloride of calcium, 1·27; total, 81·44 (the remainder upon 100 appears to be impurities, among which is clay). The mass, as brought up from the mine, is broken up, and next ground to a fine powder, then treated with warm water, and the chloride of potassium separated, and, having been dried, is chiefly used to be converted into nitrate of potassa (by means of nitrate of soda) for gunpowder manufacture. Common salt has been obtained at Kalutz for a series of years in quantities of nearly 100 tons daily.

Phosphatic Mineral Deposits in France.—M. J. Dumas.—The author exhibits specimens of a native phosphatic mineral, found near Caylux and Cajarc (Lot) some years ago; similar deposits have been found in the Département of Tarn and Garonne, samples of which gave, on analysis, 32·62 per cent of phosphoric acid, equal to 70·64 per cent of tribasic phosphate of lime. It appears that these deposits are sufficiently extensive to be quarried.

Statico-Chemical Researches on the Phenomena Observed by the Mutual Precipitation of Dilute Solutions of Salts of Silver by Hydrochloric, Hydrobromic, and Hydriodic Acids, and by Chlorides, Bromides, and Iodides.—M. Stas.—This excellent and very exhaustive essay bears especially on Gay-Lussac's process for the assay of silver by the moist way.

Thermo-Chemical Researches on Ammoniacal Salts.—Dr. Berthelot.—Continuation of this essay.

Conversion of the Glucoses into Monatomic and Hexatomic Alcohols.—G. Bouchardat.—The author describes at length how, by the application of sodium amalgam (3 per cent sodium), a solution of glucose yields a mixture of ordinary alcohol and of isopropylic alcohol. Sugar of milk, in concentrated solution, yields by the same process similar products. As regards lactine, the author states that it may be made to yield two different glucoses, one of which forms, by hydrogenation, dulcite, and, by oxidation, mucic acid; while the second yields, by hydrogenation, mannite—

$$C_{24}H_{22}O_{22}H_2O_2 = \underbrace{C_{12}H_{11}O_{11}}_{\text{Galactose.}} + C_{12}H_{11}O_{11}.$$

On Hexabromide and Hexachloride of Silicium.—C. Friedel.—Notwithstanding the high scientific merits of this essay, its contents are not suited for useful abstraction.

Method of Determining the Gases which are Formed by the Explosion of Nitro-Glycerine.—L. L'Hote.—The author introduces nitro-glycerine into an eudiometer-tube, wherein a mixture of oxygen and hydrogen is contained. When only a small quantity (6 centigrms.) of nitro-glycerine is operated upon, the tube resists the force of the explosion. 1 grm. of perfectly pure nitro-glycerine yields 284 c.c. of gas, composed, in 100 parts, of:—Carbonic acid, 45·72 deutoxide of nitrogen, 20·36; nitrogen, 33·92.

Bulletin de l'Académie Impériale des Sciences de St. Petersbourg, Vol. xvi., No. 5, 1871.

This number contains the following paper relating to crystallography:—

Crystals of Cerusite (White-Lead Ore) more Especially as Found in Russia.—N. v. Kokscharow.—Illustrated by magnificently executed engravings. The contents strictly belong to crystallography.

Journal für Gasbeleuchtung und Wasserversorgung, No. 19, 1871.

The contents of this number relate strictly to matters concerning gas- and water-works' engineering and management, but, in speaking of a severe fire at the Darmstadt gas-works in August last, the editor (Dr. Schilling) observes that this fire, originating by lightning falling upon the chimney of the aforesaid gas-works, has proved the inefficiency of lightning conductors, even when, as was the case in this instance, well made and in good working order, in the event of very severe thunderstorms taking place.

Polytechnisches Journal von Dingler, first number for October, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Observations on the Preparation of Malleable Cast-Iron.—Dr. E. F. Dürre.—This paper contains a detailed historico-practical account of a branch of industry which was originally a French invention (Réaumur), but the pig-iron preferably used for making the material is that obtained from the Ulverstone district.

Studies on Blast-Furnaces for the Smelting of Iron Ores.—C. Schinz.—The continuation of this exhaustive memoir, there being added to this portion several tabulated forms exhibiting the average specific heat of fuel.

So-Called Scott's Cement.—F. Schott.—By Scott's cement is understood a peculiar preparation of lime and sulphur, obtained either by exposing lime ignited to redness to the vapours of sulphur, or by passing sulphurous acid over lime at the ordinary temperature. The contents of this very lengthy essay are detailed under the following headings:—Preparation and nature of this cement, which varies in composition (but this may be elucidated by the following percentage figures:—Sulphuric acid, 31·65; lime, 53·70; sulphuret of calcium, 13·56; sulphite of lime, 2·09); preparation of the cement from gypsum and lime; the hardening of this cement, and the conditions under which it takes place; practical observations.

Testing of Potatoes by means of a Solution of Common Salt. Dr. W. Schultze.—This paper, elucidated by a series of tabulated forms exhibiting results of experiments, treats on the estimation of the quantity of starch contained in potatoes, by means of the specific gravity of the tubers, as determined by the aid of strong brine.

Les Mondes, October 26, 1871.

This number opens with an exhaustive description of an important work, the first part of which has been just published, viz.—

Physical Atlas of France, Edited by the Observatory of Paris, under the Direction of MM. Delaunay and Marié-Davy.—Without entering into the minute details here described, we quote the main headings of the several divisions of this work (published by MM. Hachette):—Political and administrative divisions of France; the soil and waters of France; climatology, agronomy; industry, commerce, navigation; population.

Most Advantageous Arrangement of Galvanic Batteries.—Count du Moncel.—An algebraico-physical essay.

November 2, 1871.

Production of Hydrogen on the Large Scale.—H. Giffard.—The author's apparatus (not further specified) for the production of hydrogen, by passing steam over red-hot iron has been constructed and tested at M. Flaud's works at Paris. It appears that 2 cubic metres (rather more than 70 cubic English feet) of the gas are generated per minute of time; after awhile, the oxide of iron (the current of steam having been previously shut off) is reduced again to the metallic state, by a current of dry oxide of carbon gas.

Estimation of the Value of Beet-Roots for Sugar Manufacture by Chemical Analysis.—M. Felz.—This essay treats on a method, invented by M. Tolopihine, of determining the value of the beet-root juice by a very sensitive and, for this purpose, expressly constructed areometer.

New Method of Applying Bone-Black in Sugar Refining.—E. Rousseau.—The chief point of interest in this paper is that, instead of granulated black, the author proposes to use the material in the state of powder.

Steam-Boiler Incrustation.—Rev. F. Moigno.—The substance alluded to was found to consist, in 100 parts, of:—Water, 3·0; silica, 6·05; magnesia, 3·67; oxide of copper, 11·90; oxide of iron, 7·50; lime, 20·25; alumina, 2·25; carbonic acid, 14·10; traces of sulphuric acid and chlorine; organic matter, 27·68. The water used to feed the boiler was the condensed steam from boiling beet-root juice.

New Kind of Furnace for Reviving Bone-Black.—M. Derrien.—According to the detailed financial account here given, the furnace alluded to is very economical in use.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, No. 223, July, 1871.

This number contains the following original memoir relating to chemistry and collateral sciences:—

Report on the Bichromate of Potassa Battery in general, and particularly on the Arrangement of MM. Chutaux, Delaurier, and Barker.—Th. Count du Moncel.—This interesting paper, illustrated by a series of woodcuts, leads to the following conclusions:—Of all the galvanic elements used in industry and arts, those with bichromate of potassa yield the greatest electro-motive force, are the most economical, give off no irritating vapours, but are, on the other hand, not very constant, and become strongly polarised. These defects are less marked in the Delaurier element with two liquids, and are also greatly obviated in the Chutaux elements with constant discharge *(écoulement continu)*; the use of the Chutaux element with sand and constant discharge offers peculiar advantages in every respect for electric telegraphy and all similar applications, because this element is for equal force more economical than the Daniell element. The Delaurier element with two liquids may be advantageously used instead of the Bunsen element when strong electric currents are required; in order to obtain a continuous and energetic action with the bichromate of potassa battery, this can only be effected by the use of the air current, as invented and applied by M. Grenet; by the addition of bisulphate of mercury to the bichromate solution in the Chutaux element, a very continuous and energetic electric current may be obtained.

Le Moniteur Scientifique Quesneville, No. 355 and 356 (double number), October 1 and 15, 1871.

The original papers and memoirs relating to chemistry and allied sciences in this number are:—

On Anthracen and its Derivatives.—E. Kopp.—The continuation (see CHEMICAL NEWS, vol. xxiv., p. 120) of the very elaborate and exhaustive essay on this subject, divided into the following sections:—Action of bromine upon anthracen; action of oxidising substances on anthracen; action of chromic acid on anthracen. This essay is to be continued.

Diffusion of Albuminous Liquids when placed in Contact with Distilled Water.—A. Commaille.—The contents of this paper bear strictly upon physiology rather than chemistry, but we call attention to its contents on account of the light it throws upon the active principles in vaccine lymph and other animal fluids.

Second Memoir on the Action of Ammonia upon Phosphorus.—A. Commaille.—This essay describes a series of experiments, under the following headings:—Action of ammonia upon the phosphuret, P_2H; action of supersaturated solution of liquid ammonia upon phosphorus; action of liquid ammonia upon phosphorus assisted by heat; action of dry ammonia gas upon phosphorus (contrary to what is stated in the "Dictionnaire de Chimie," vol. i., p. 216, *dry* ammoniacal gas does not exert any other action upon phosphorus than the change that element undergoes by exposure to light); action of carbonate of ammonia upon phosphorus; action of an alcoholic solution of ammonia; action of the last-named assisted by heat; action of water upon the deep green coloured phosphorus, and search for ammonia in that phosphuret or hydrogen.

Researches on the Influence of Temperature upon the Optical Rotatory Power of Ordinary Sugar and Inverted Sugar.—C. Tuchschmid.—We regret that the contents of this excellent and practical essay are not suited for abstraction, on account of the necessity of reproducing, for the proper understanding of the subject, a series of tabulated formulæ.

Destruction of Torpedoes when placed under Water.—A. Guiot.—This interesting paper embodies the author's ideas on this subject, as communicated to M. le Ministre de la Marine.

NOTES AND QUERIES

Gallic Acid.—(Reply to S. E. P.)—Be kind enough to notice Errata inserted in the same column below your query; then substitute HO to SbO_3 in the correct formulæ. They then become—

(1). $HO(C_7HO_5)_3+3HO=C_{14}H_6O_{10}$.

(2). $HO(C_7HO_5)_3+5HO=C_{14}H_8O_{12}$.

Formula (1) is that of gallic acid dried at 100°; (2), that of crystallised gallic acid. Then follows this little calculation:—

Hugo Tamm's formula $=C_{14}H_6O_{10}$.

Hugo Schiff's formula $=C_{14}H_6O_{10}$.

Consequently—

Hugo Tamm's formula = Hugo Schiff's formula.

Divide both members of equation by "Hugo's formula," and you will find that—

Tamm = Schiff.

In other words, the two Hugo's agree splendidly together.—HUGO TAMM.

MEETINGS FOR THE WEEK.

MONDAY, Nov. 20th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "Consciousness" (Course of Elementary Physiology).
—— Medical, 8.

TUESDAY, 21st.—Civil Engineers, 8.
—— Zoological, 9.

WEDNESDAY, 22nd.—Society of Arts, 8.
—— Geological, 8.

THURSDAY, 23rd.—London Institution, 7.30. Mr. P. L. Simmonds, F.R.C.I., F.S.S., on "Science and Commerce; Illustrated by the Raw Materials of our Manufactures."
—— Royal, 8.30.
—— Philosophical Club, 6.

FRIDAY, 24th.—Quekett Microscopical Club, 8.

TO CORRESPONDENTS.

E. K.—"Elements de Chimie," par M. Victor Regnault (Paris: Victor Masson et Fils), is one of the best for your purpose; as there are several editions be careful to order the last.

C. Claus.—We cannot insert your reply to our querist, "W. S."; it is better adapted for our advertisement columns than for "Notes and Queries."

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THE CHEMICAL NEWS.

Vol. XXIV. No. 626.

ON THE

METHOD OF ASSAYING SILVER ADOPTED IN THE ASSAY OFFICES OF H.M. INDIAN MINTS.*

By H. E. BUSTEED, M.D.,
H.M. Madras Army, Officiating Assay Master, Calcutta Mint.

The process of assaying silver about to be considered is one which (on a large scale, at least) is peculiar to the Indian Mints: it has been in practice in the Calcutta Mint since 1850; it extended thence in course of time to the Bombay Mint, and more recently to the Madras one.

Though it has been favourably reported on, and described more or less fully as an official duty by various assay officers to local Mint Committees, &c., &c., no steps, that I am aware of, have yet been taken towards making more public the manipulatory details of the process.

It has been suggested to me that it might prove not only interesting, but useful to have described the practical working of a system of the utility of which great experience has been afforded in the Indian Mints, as, on assays made by it, an amount of silver bullion reaching on an average the value of over seven† millions sterling is annually purchased by these mints, and by it a silver coinage to about the same value annually, is watched over as regards its purity and maintained up to the legal standard of fineness.

I propose, therefore, to give a somewhat detailed account of the process, omitting only the minor steps in the manipulations, which it would be unprofitably tedious to attempt to bring within the compass of a description; practice alone can lead to an acquaintance or can familiarise with these.

To render more intelligible to the general reader the nature and object of this process of assay, and wherein it contrasts with the other methods in more general use, it may be desirable in the first place to allude briefly to the principles on which those other systems depend for their results, avoiding technicalities and details, as a full description of those processes may be found in any work on assaying, and in most works of chemistry and metallurgy.

In general terms, then, it may be said, that the particular duty of an assayer is to ascertain the proportion of pure gold or silver present in any specimen of mixed metal submitted to him for examination, so that from this report the value may be assigned by calculation to the mass which the sample is supposed to fairly represent.

This is done by the separation of the precious metals from the coarser ones with which they may happen to be alloyed.

The most ancient plan for thus separating silver is that by "cupellation" which attains the end in view, owing to the fact that silver resists the action of air, at a high temperature, while the baser metals under identical circumstances become oxidised, and if a certain proportion of lead be present, its very fusible oxide unites with the other oxides produced during the operation and renders them capable of soaking with it into a porous little vessel (made of bone-ash), called a cupel, leaving behind on the surface of each cupel a glistening button of pure metallic* silver, whose weight can be accurately ascertained.

A certain weight of the specimen of the metal to be assayed is folded up in a certain proportion of thin lead and placed on a cupel. The operation is conducted in a suitable oven (called a "muffle") and furnace. When the remaining little button of silver has cooled, it is weighed and the loss of weight of the specimen operated on represents the baser metals that have been removed; thus, if the specimen weighed 20 grs. and the resulting bead of pure metal weighs 15 grs., the mass would be reported to contain 75 per cent of pure silver.

Several contingencies, however, and collateral circumstances (known to assayers) tend to modify the result of an assay by cupellation, and the assayer has to consider them all in arranging his compensation; failing this the report would be most erroneous; everything, therefore, depends on his skill and experience; but even in the hands of the most experienced and the most skilful the result will fall short of accuracy, and a margin for error must be left, owing to unavoidable imperfection in the assay: the average range of this error ought not, however, to exceed ¼ dwt. (12 grs.) in the lb. troy, or say 2 parts in 1000; so that this method is sufficiently accurate for keeping a coinage tolerably close to "standard" and even well within† the legal limits on either side of it.

The assay report furnished by it, however, is too remote from accuracy, *i. e.*, is not within sufficiently narrow limits to fairly regulate the valuation of merchants' bullion with satisfaction to seller or buyer, the latter being, in this country, almost invariably the mint.‡

The above was the method of assay prevailing in this mint up to 1850. Though it is still practised by many English assayers of great skill, it has been almost entirely superseded on the Continent in consequence of its shortcoming by one contrived by Gay-Lussac, which is less dependent on the individual operator.

This, known as *La voie humide*, or the volumetric process for ascertaining the fineness of silver bullion, consists in precipitating the silver as an insoluble chloride from the solution in nitric acid of a certain weight of the metal to be examined, and in effecting this by the use of a solution of common salt (chloride of sodium), containing a known proportion of salt; this is added gradually till just sufficient has been used to throw down the whole of the silver present as chloride; as chlorine unites with silver in definite chemical proportion, the amount of silver present can be easily and accurately estimated by merely ascertaining the amount of salt which has been exactly necessary to convert the whole of it into chloride of silver.

This is the method practised at the Paris Mint, and by the eminent outside assayers to the Royal Mint of Great Britain, and I believe at most of the European and American Mints.

Assays can be confidently made by it to ¼ dwt. or about 6 grains in the pound troy, or even indeed to half this, say to ½ part (0·5) in 1000.

The volumetric system is especially applicable where the silver to be assayed by it is alloyed with copper only, and where the fineness is approximately known beforehand; both these conditions to its successful usage exist

* From the *Journal of the Asiatic Society of Bengal*.

† Average for last 20 years.

* Should gold or platinum happen to be present in the specimen assayed, as they also resist oxidation, they remain behind, included in the "button," and are, under ordinary circumstances, estimated as silver.

† It being impossible in the operations of a mint to produce a certain mixture of metals (such as silver and copper) with mathematical accuracy, a certain deviation is allowed above or below the legal standard. In India this deviation or "remedy" in fineness is 1 dwt. in the pound troy, *i. e.* 1-220th part, equal to about 4½ parts in 1000.

PS. Since this paper was read, a Legislative Act of the Government of India has been promulgated which declares that the remedy in fineness is not to exceed 2 thousandths for the rupee and half rupee, and 3 thousandths in the case of the smaller silver coins.

‡ That is, the mint receives the bullion in bulk and returns it in coin, a certain seignorage to cover expenses being deducted.

in such mints, where the only silver assays made are those of metal already alligated for coinage to the legal standard.

It is acknowledged by its advocates that the presence of mercury in the alloy would materially interfere with the accuracy of the assay, and a certain (rather tedious) modification of the process is essential to avoid error under such a contingency.

Its adoption in the Indian Mints was not considered desirable by their assay officers for reasons of which the following are a few:—

1. A vast amount of the silver which comes to the Indian mints, (viz., China and Rangoon Sycee, bazaar cake silver, Japanese coins, &c.,) contains not only mercury, but lead and other coarse metals.

2. No sufficiently approximate idea of the fineness of such silver can be formed beforehand, thus necessitating a preliminary assay by cupellation.

3. The high temperature of an Indian climate renders it impossible to retain the solution of salt at an uniform strength for any length of time; the evaporation and concentration derange the equivalence which it is essential to maintain between it and the proportion of silver meant to be precipitated by it; thus involving very frequent tedious testing to ascertain daily the actual strength of the standard solution.

4. The whole of the important manipulations should be gone through by the assay master himself or his deputy, a labour beyond their strength in this climate with a very large daily number of assays of various finenesses; and one which would preclude the possibility of his attending to the many other important duties which devolve on the head of an assay office to a mint in India.

The method of assay by cupellation, then, not being accurate enough for the requirements of trade, and that by the French process being considered unsuited to the peculiar work devolving on the assay officers of the mints in India (where there are no bullion refineries), it became necessary here to adapt and introduce a system more likely to fulfil all the objects required of it.

In the volumetric system it has been seen that the proportion of silver present in a mixed metal is estimated by ascertaining the exact amount of salt which it took to precipitate it in the form of chloride of silver; the same end can be attained by collecting, drying, and weighing the chloride itself. One hundred parts of it represent 75·3 of pure (metallic) silver.

Hitherto this process when resorted to at all seems to have been restricted to a very limited application, such as a solitary analysis for some special purpose, possibly the examination of a standard "trial-plate" where the greatest accuracy was required, or perhaps an assayer would resort to it as a delicate confirmatory test of one or two of his assays by the volumetric method.

Some books which go into the principles and details of the assaying of silver, make no mention of it whatever; others allude to it merely to dismiss it as "tedious and less exact" (than the French process). In theory, the process is allowed by all to have the merits of accuracy and simplicity, but it is implied that the tediousness and difficulties of the manipulations (supposed to be) necessary to the carrying out of the theory, detract materially from its practical value; certainly the few details of the manipulations occasionally given, such as the weighing the chloride of each assay (after collecting on a filter and fusion)* in a porcelain capsule, previously counterpoised, were calculated to deter from the idea of this process being ever made available for the assay of silver on a large scale.

The credit is due to Mr. J. Dodd, a former assay master of the Calcutta Mint (and a surgeon in the Madras army), of having encountered those difficulties of manipulation, and of having overcome them, inasmuch as he modified and simplified them, and in short so systematised the whole practical working of the process as to render its application to the assaying of silver, to any amount, easy, accurate and economical.

That this result was not attained without much labour and much patient investigation, and that his successors in office acknowledge their deep obligation to Mr. Dodd's intelligent industry, will be apparent from the officially recorded testimony of two of them, which I think it due to him and to them not to withhold, when making mention of the practical carrying out of this method of assay. Viz., Sir Wm. O'Shaughnessy, who was deputy assay master of the Calcutta Mint in Mr. Dodd's time, and himself a practical chemist of high reputation, writes in April, 1852:—

"Previous to making overcharge of the assay office to Dr. Shaw on the occasion of my proceeding to England on duty, I deem it an act of justice towards the assay master, Mr. James Dodd to place upon record an acknowledgment of the eminent service Dr. Dodd has rendered to the assay department and to the art of assaying generally by his investigation of the analytical process for assaying silver, his improvements in the manipulation of the process, and his admirable system of arrangement which renders it capable of effecting in 24 hours more assays of silver than the mint can ever require in that time."

Dr. Shekleton, the present assay master (now on leave), an assayer of long experience, when giving officially to the Mint Committee at their request a detailed statement of the process says (April, 1855):—

"It would be quite impossible, however, by any mere description to form an adequate idea of the eloquence of the process, or the perfection to which it has been brought by the skill and unwearying industry of Mr. Dodd, late assay master. To him is due, not only the merit of its introduction, but the removal of every practical difficulty in its working; the confidence with which his system has been adopted by all his successors is the highest tribute to its completeness and efficiency."*

Method of Assaying Silver by the "Chloride process" (as conducted in the Calcutta Mint) given somewhat in detail.

The samples (or "musters") for assay are, to save time, first approximately weighed by an assistant; they are then placed (each sample in duplicate) in small shallow saucers of polished copper, and so brought in batches of 40 on a board, containing in numerical order receptacles for the little saucer, to the assay master who, in the delicate assay balance, exactly brings each sample to the one required weight.†

As each sample is weighed, it is transferred from the platinum skiff of the balance to a bottle on the left hand of the assayer, by means of a small copper funnel. The bottles‡ for this purpose are held in readiness for the musters by an assistant, and, on receiving them, are removed into the laboratory in batches of six.

On being taken to the laboratory, they are ranged on a circular platform or turn-table, and there one of the (European) assistants adds by means of a pipette 1½ drms. of nitric acid to each bottle, which are then (without their stoppers) transferred to a sand-bath and exposed to a considerable degree of heat, till solution of the contents is effected.

The specific gravity of the nitric acid used is generally 1200, *i. e.*, in the case of known alloys of only copper and silver, such as the standard meltings, coins, &c., but when

* Of course in practice it would be necessary periodically to recover the silver (by reducing it to the metallic state) from the closely attached fused chloride in each capsule,—a very tedious measure.

* When in the Madras Mint, I remember seeing recorded similar testimony from Dr. Shaw, the assay master, when describing the process on recommending to the Madras Government its adoption in his office.

† The amount of this weight will be more particularly referred to further on.

‡ The chief appliances will be described more fully in an appendix.

the nature of the alloy is uncertain, such as bazaar silver, or some sycee (where the presence of mercury may be suspected), a stronger acid of sp. gr. 1320 is used. It has been found, too, by experience that the chlorides from fine bar silver eventuate better when the solution has been effected in the stronger acid.

When the samples have been completely dissolved,* the bottles are brought back to the platform and there each receives through a glass funnel† about six ounces of cold distilled water.

There is then added to each bottle through a glass pipette as before 1½ drms. of hydrochloric acid, sp. gr. 1060, which immediately converts the silver present into the characteristic white precipitate of chloride of silver, which forms in slow-falling curdy volumes.

The stoppers (previously dipped in distilled water) are then carefully replaced, and the bottles are allowed to stand for five minutes.

The bottles are next well shaken two and two by the laboratory workmen for three or four minutes till the chloride aggregates and rapidly falls down; any particles which may retain attached to the neck or upper part of the bottles are washed down by a quick circular motion, and more distilled water being added to within about two inches of the neck (great caution being observed in removing and returning the stoppers), the bottles are then allowed to rest each in its assigned place on the platform for four hours.

At the expiration of that period, the clear supernatant liquid (blue-coloured when copper is present) is removed by a glass syphon, which is lowered to within an inch of the deposited chloride, the greatest care being taken that none of it is drawn up into the syphon. As each platform is made to revolve on its centre, according as each bottle is syphoned, the operator sitting in one place brings the platform round till the next bottle in order gets under the syphon, which is thus in rotation lowered into each. The fluid escapes from the long leg of the syphon through a funnel fitted in the table to a jar placed underneath.

After the first syphoning, the bottles are immediately filled again with distilled water, and each gets a quiet circular motion for a few moments, and the precipitate is again allowed to settle as evenly as possible; this time it will be sufficient to allow them to rest for two hours, when they are again syphoned as before and the stoppers returned.

Under ordinary circumstances these two washings are sufficient, but if the silver is evidently "coarse," a third or fourth washing is similarly given.

When it is considered that the chlorides have been sufficiently washed, the bottles are placed for half an hour in a reclining position on their platforms; this causes the chloride to fall and settle to one spot and renders its removal from the bottles more easy.

Meantime a pneumatic trough has been got ready, capable of containing a batch of twenty inverted bottles; the trough is filled with distilled water; for each bottle there is placed on the floor of the trough a small porcelain saucer holding a little Wedgwood crucible or cup, each numbered to correspond to the bottles. A laboratory workman then removes the stoppers from the bottles and hands them one by one to an assistant at the trough, who, placing his forefinger over the mouth of each bottle inverts it over its corresponding cup, and does not remove his finger till the neck of the bottle has passed down through the water and well into the cup; then the finger being taken away the bulk of the chloride falls by its own weight to the bottom of the cup.

The bottle is held in the position by two rings, one (the larger) above the other, which are fixed to the sides of the trough; this arrangement retains each bottle *in situ*, at the proper slant, and admits of the operator gently revolving or slightly raising the bottle with his left hand, while with the right he patiently taps the bottom and sides till the whole of the chloride has been dexterously got out; the finger is then again placed over the mouth and the bottle raised up through the rings and handed (mouth upwards) to the assayer, or to the supervising assistant standing by, who carefully examines it to see that every particle of chloride has been dropped into the cup. When this part of the manipulation has been neatly done, none of the chloride falls over into the saucer which is placed as a precautionary measure under each cup.

When the chloride falls into the cup, it is in an uneven lumpy state and not in a favourable condition for being uniformly dried; it has, therefore, next to be broken up. For this purpose the cups (containing the chlorides, and water to the brim) on removal from the trough are taken in batches on a tray to an assistant seated at a steady table, who first carefully decants off about half the water, and then with a finely polished glass rod (four inches long and one-third of an inch thick) gently stirs and beats the lumpy precipitate, while revolving the cup on the table; this causes it to lie evenly and loosely at the bottom of the cup as a purplish grey powder, not too fine.

He next washes the rod over the cup with distilled water from a drop bottle, lest any of the chloride may be adhering to it, and sprinkles a drop or two from it on to the surface of the water in each cup, so as to cause to sink any minute particles that may happen to remain floating. He then, after an interval of ten minutes, drains off about three-fourths of the supernatant water, which he lets run down the rod into a vessel near him, and with a tap or two with the rod to the outside of the cup to still further loosen the deposit, this part of the manipulation is concluded.

The crucibles are next taken to the drying furnace, where a steam bath is ready to receive them; on the perforated upper plate of this they are ranged, and allowed to remain for about an hour. This gradually, and without spurting, frees the chlorides from moisture, which may be known by their caking, *i. e.*, leaving the sides of the cups round the edges and forming at the bottom of each a loose cake, resembling somewhat a gun-wad. The crucibles are then arranged on a hot air plate and there exposed to a temperature of between 300° and 350° (F.) for about two hours, till thoroughly dried, when they are ready for weighing.* When the above manipulations have been carefully and satisfactorily gone through, each little cup contains an unbroken, tolerably firm, cake of chloride of silver, lying unattached, which admits of being easily grasped with a pair of forceps, and cleanly lifted out of the cup and conveyed to the skiff of the assay balance in which it is weighed. The cups are generally brought from the laboratory to the assayer at the balance in batches of eight or ten. A "standard," synthetically prepared of pure silver and copper, and an assay pound of pure silver are introduced with each day's set of assays, and their chlorides dried with the others, and the analysis of them verified before weighing the rest. Occasionally these "checks" are also fused and weighed in a porcelain capsule, but the weight found never differs from that of the chloride merely dried as above.

Once or twice a month, the silver is recovered from the accumulated chlorides, which are well pounded in a mortar and brought to a powder and then mixed with a proper proportion of chalk and charcoal, and put into a wrought-iron crucible and reduced with heat. The metallic silver so recovered is transferred to the mint.

Under the circumstances of the solution and of the precipitation as detailed above, should any gold happen to be present in the sample operated on, it is not dissolved, and, therefore, becomes entangled with the precipitated

* A slight residuum of gold as a black powder is very generally seen.

† The portion of this which enters the neck of the bottle is protected, or sheathed, with an inch of India-rubber tubing to prevent chipping, if struck against the neck of the bottle.

* The chlorides are weighed warm, to obviate the risk of their absorbing moisture; a precaution especially necessary in the heavy monsoon weather in this country.

chloride of silver and dried and weighed with it, and accordingly comes to be regarded and valued as silver. In this the chloride process resembles that by cupellation, which likewise takes no distinguishing cognisance of gold, and both these processes contrast in this respect with the volumetric one, which is a rigid analysis for silver alone; so that, strictly speaking, an assay conducted by either of the first named methods ascertains the proportion present of "the precious metals," *i. e.*, silver and gold.*

Should mercury be present it does not interfere with the result, when the solution has been effected in excess of nitric acid with strong heat. Thus the mercury becomes peroxidised, and hydrochloric acid forms no precipitate in solutions of mercuric salts; any mercuric chloride resulting from the combination would remain in solution and be washed away in the course of the process.

Should lead happen to be present, hydrochloric acid gives no precipitate in a dilute solution, the chloride of lead being soluble in a certain proportion of distilled water; but even were the proportion of lead to silver tolerably large, and the chloride of lead happened to be thrown down, the repeated washings would dissolve and get rid of it.

(To be continued.)

EXPERIMENTS ON THE PREVENTION OF THE DEVELOPMENT OF FUNGI IN AQUEOUS SOLUTIONS OF TARTARIC ACID,

AND THEIR BEARINGS ON THE THEORIES OF THE ORIGIN OF, AND CONDITIONS ESSENTIAL TO, LIFE.†

By W. H. WOOD.

1. In all cases of original scientific research, the investigator sets before his mind's eye the attainment of one or more of several results. He either wishes by his experiments to train his mind to the observance of phenomena and to the deduction and induction of results therefrom, the truths arrived at being, in this case, only of secondary importance; or he wishes, by such research, to augment the amount of truth and knowledge of the particular branch of science with which his research stands connected. Added to these may be the desire to apply the results so obtained in the arts and manufactures either for general or personal benefit, The love of scientific research for its own sake, without the wish to apply it at all to ulterior purposes, must for ever stand pre-eminent over researches made for any other end, for we consider the discovery of the truth, both scientific and otherwise, to be the duty as well as the highest aim and the noblest occupation in which man can engage.

2. The experiments about to be detailed were made with the intention of giving the experimenter a training, to some extent, such as has just been indicated, but at the same time the importance of the truths to be discovered was not considered as standing in the second place, but as being of equal, if not of greater moment.

3. It has long been known to chemists that aqueous solutions of tartaric acid exhibit—at a shorter or longer time after their preparation—signs of decomposition, as indicated by the growth of fungi, and the production of a small quantity of acetic acid in them. That this fact is generally known, will, I think, be evident from the following quotations:—

(*a*). The late Professor Miller, in his "Chemistry," vol. iii., p. 438, 3rd edition, says: "Its aqueous solution becomes mouldy when long kept, and is slowly converted into acetic acid."

(*b*). Richardson and Watts's "Chemical Technology," vol. i., part v., p. 163, says: "The solution becomes mouldy by keeping, producing a small quantity of acetic acid."

(*c*). Watts's "Dictionary of Chemistry," vol. v., p. 677, says: "The aqueous solution becomes covered, after a while, with a fungous growth."

These quotations might be greatly multiplied, but we think sufficient have been given to show that the fact above stated is generally known. Anyone, moreover, who has had a moderate amount of practice in chemical analysis must have proved the truth of this statement many times; and it was from coming in contact again and again with such solutions, that I was led three-and-a half years ago—simply from a desire to extend the domain of truth, and to train my faculties of observation and reasoning—to commence the course of experiments, some of which, with their results and deductions drawn from them, I intend to describe to you this evening.

4. My first experiments were made on July 18th, 1867. About two ounces of solution of tartaric acid was made by boiling 1 ounce of crystals of the acid in Halifax town's water as drawn from the tap. The solution was filtered, and divided into two portions of about an ounce each, and these placed in 2-oz. stoppered bottles, marked A. and B. To A. two drops of creosote were added, while B. was not subjected to any further treatment. These solutions are before you (part of B. has been used for another experiment), and you will see that up to the present, no formation of fungi or mould has occurred in either. The conclusion therefore seems warrantable from these experiments, that boiling the solution prevents the development of fungi.

5. This conclusion was—ten months after preparing the solutions just described, viz., on May 22nd, 1868—put to the test of experiment, in order to prove its truth or falsity. For this purpose three solutions of the acid were made with the same kind of water as before: No. 1 solution, by dissolving 40 grs. of acid in 1 oz. of the water, and filtering the solution without even warming; No. 2 solution, by dissolving the same amount of acid (40 grs.) in the same quantity of water (1 oz.), which had just been boiled, and was still hot, filtering as before; No. 3 solution was of the same strength as Nos. 1 and 2, but the solution was boiled for a few minutes, and then filtered. These solutions are also before you, and you will observe that while No. 1 solution contains—what was some time ago white mould with brownish nuclei—but which has now become almost entirely brownisb, Nos. 2 and 3 solutions contain only a slight amount of sediment, without the least appearance of fungi. From this it is evident that boiling the solutions does prevent the development or formation of the fungi or mould. This treatment of the solutions (viz., the boiling), has, in every case but one in which it has been tried, been found to be efficacious; the case in which fungi have developed, even after boiling, is possibly explainable on certain grounds, as I shall endeavour to show, as also, maybe, a case in which an unboiled solution has not developed fungi.

6. The next solution before you (to take them in the order of their preparation)—and I should state that I shall only describe these, though they are not more than one-half of the solutions I have prepared,—is marked B, and is one of three experimented with on August 12th, 1868. A mouldy solution of the acid was filtered and divided into two portions marked B. and C. B. was not heated, and has, as you see, again developed fungi, while C. (see Appendix), which is at Halifax, had not, the last time I saw it, developed any.

7. The question suggested itself to my mind, as to whether exposure to light had any influence upon the development of the fungi. To determine this point, I made

* Much of the silver which finds its way to the Indian mints is rich in gold; for instance, sycee contains on an average somewhat about 12 grs. in the troy pound. This in minting operations is considered as silver, and as such it enters into the coinage. There being as yet no refineries established here, through which such silver could pass to the mechanical departments of the mints the silver coins made during a period when a heavy importation of sycee had been worked up. contain as much as 4 or 6 grs. of gold in every 32 tolas or 1 pound troy.

† From the *Transactions of the Cleveland Litarary and Philosophical Society.*

on the 21st of September, 1868, two solutions (Nos. 1 and 2) of which No. 1 is before you, by dissolving 20 grs. of the acid in 240 grs. of Halifax water in the cold. The solutions were filtered, and No. 1 was exposed to light, while No. 2 was shut up in a dark cupboard. When examined on the 11th of January, 1869, No. 1 had developed fungi, while No. 2 had not. No. 2 being at Halifax, I cannot state positively whether fungi have developed yet or not (see Appendix). Anyhow, it is evident from these experiments that exposure to light does cause the fungi to develop more rapidly if it is not essential to their development.

8. The character of the water employed next suggested itself as possibly influencing the development of the fungi. To ascertain to what extent this possible cause operated, I made three solutions with Manchester water in the laboratory of Owen's College, in December, 1868, and January 1869, as follows:—Two solutions were made (the proportion of acid to water not being noted) with distilled Manchester water. No 1 was filtered but not heated; No. 2 was filtered and boiled (time of boiling not noted), and a third solution (No. 3) was made in undistilled and unboiled water, the solution being filtered. No. 1 solution has, as you see, undergone the usual change; No. 2, which was (as I have just stated) boiled, has, notwithstanding this, developed fungi, though in much smaller quantity than No. 1 solution, while No. 3 solution, which should, according to previous trials, develop them most readily, has not done so at all even yet, and, therefore, I shall have to remark on the two latter solutions specially.

9. A further series of experiments on this point (*i.e.*, to determine the influence exerted by the kind or quality of water used), I have made since coming to Middlesbrough. This last series of experiments has been conducted by the light of the experiments already described (as well as others), and modifications have been made in the mode of experiment which are not altogether unimportant.

Instead of the solutions being stoppered or corked up in bottles—so that contact with the outer air is only possible when the stoppers or corks are removed—these solutions have, as you see, been filtered into flasks, over the mouths of which (with two exceptions purposely left exposed), loosely-fitting watch-glasses have been placed. By this contrivance the introduction of dust into the solutions is prevented, while the air has (when alterations of temperature and pressure occur), comparatively free ingress and egress. The flasks were cleaned before use, by shaking some sulphuric acid in them, to destroy organic matters, &c., and were then washed out six times with filtered steam water. The solutions are all of the same strength, viz:—10 grms. of the acid to 50 grms. (or c.c.) of either Middlesbrough water or filtered steam water. They were prepared on the 9th of January, 1871, and numbered 1 to 6. They were then subjected to the following treatment:—

Middlesbrough Water.	No. 1, left exposed to the air and dust after being filtered and then boiled for five minutes.
	„ 2, covered after filtration.
	„ 3, covered after filtration, and boiled for five minutes.
Steam Water, filtered.	„ 4, left exposed to air and dust, after being filtered and then boiled for five minutes.
	„ 5, covered after filtration.
	„ 6, covered after filtration and then boiled for five minutes.

No growth or formation of fungi has yet occurred; the strength of the solutions appears to exercise some influence on the length of time required before the fungi make their appearance, but its exact bearing on the point has yet to be decided by further experiments.

10. *Citric Acid.*—An acid contained in the juices of the citron, lemon, orange, &c., and which is closely allied to tartaric acid, exhibits like it, similar phenomena in aqueous solution. The application of the knowledge gained as to tartaric acid solutions, to solutions of citric acid follows, therefore, in natural sequence. I have, accordingly, prepared two solutions of citric acid, and find so far, that the law (if we may dignify it by the name) applicable to tartaric acid solutions, viz., that boiling the solutions prevent subsequent decomposition, holds good for citric acid solutions. For, of the two solutions before you (prepared January 10th, 1871, and numbered 1 and 2), by dissolving 10 grms. of the acid in 100 grms. (c.c.) of Middlesbrough water, filtering, &c., and placing them in flasks (uncleansed by sulphuric acid, simply washed with water of kind to be used). No. 1 was filtered and left unheated, while No. 2 was filtered and then boiled for ten minutes. No. 1 has begun to develop fungi, No. 2 has not. The fungi in No. 1 solution may be well seen—as to their structure—by holding the flask between the eye and the light; they then appear as white semi-transparent globular bodies, fibrous, as if radiated from a central nucleus.

11. It was suggested to my mind that it might be possible to prevent the growth of these low forms of life in tartaric acid solutions, by re-crystallising the acid from a hot solution. Accordingly, I dissolved some crystals of the acid in hot steam water, and evaporated the solution on a sand-bath. It is somewhat difficult without constant watching to get crystals of the acid by this plan, as since the acid itself melts, it is not easy to say when the liquid has been sufficiently evaporated; the evaporation may, consequently, be continued after all the water has evaporated, the result being that the acid is, to a greater or less extent decomposed, as evidenced by the odour of burnt sugar evolved. The acid used in preparing the solution for this experiment was accidentally allowed to evaporate to this extent, and, therefore, I do not lay much stress or put much value on the result which it shows. The re-crystallised acid was dissolved in cold steam water without any filtering or heating. None of the usual appearances have yet presented themselves; but this cannot, as already stated, be considered quite a fair trial; consequently, I intend to make further experiments to elucidate this point.

12. The formation or growth of fungi in the boiled solution already spoken of may, I think, be accounted for on the ground of insufficient boiling—the time was not noted, but was not continued (so far as my memory serves me), for any great length of time. This explanation is borne out by the fact that a less considerable quantity of fungi are found in it than in the solution made at the same time which was unboiled, and this we should naturally expect to be the case. The other real or apparent exception to the general principle which I have endeavoured to establish is the third solution prepared at the same time as the one just mentioned. It was made, as already stated, with Manchester water, undistilled, and the solution was not heated, but simply filtered and corked up in the bottle. The explanation in this case I cannot as yet arrive at, I therefore leave it for further experiments to throw light upon.

13. Having now described the whole of the tartaric and citric acid solutions before you, I must attempt to trace out, as far as possible, the bearing of the results obtained on the questions of the origin of, and the conditions essential to, life. You are doubtless aware that at the present day there are two theories of the origin of life before the world, viz.: Biogenesis, or, to quote Professor Huxley's words, the theory "that living matter always arises by the agency of pre-existing living matter;" and Abiogenesis, the theory "that living matter may be produced by not living matter." Professor Huxley in his address to the British Association at Liverpool last year, showed that the evidence, both direct and indirect, in favour of Biogenesis is of great weight, though he carefully guards himself against supposing that "no such thing as Abiogenesis ever has taken place in the past, or

ever will take place in the future." Indeed, he says, "if it were given me to look beyond the abyss of geologically-recorded time to the still more remote period when the earth was passing through physical and chemical conditions, which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not-living matter. I should expect to see it appear under forms of great simplicity, endowed, like existing fungi, with the power of determining the formation of new protoplasm from such matters as ammonium carbonates, oxalates and tartrates, alkaline and earthy phosphates, and water, without the aid of light. That is the expectation to which analogical reasoning leads me (Professor Huxley); but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith."

14. To which, then, of the two the theories do the results arrived at lend support? To Biogenesis or Abiogenesis? Most decidedly they support the Biogenesis theory. Let us suppose for a moment that this theory is true, what should we expect beforehand would be the result of boiling the tartaric acid solutions? We should expect—since it is known that living matter generally is killed by being raised to a high temperature—that any living matter which the solutions before described contained would be killed, and, therefore, that no forms of life would make their appearance in such solutions afterwards—an expectation which is confirmed by actual experiment. On the other hand, let us suppose that Abiogenesis is true: how can it be explained that the simple ebullition of our solutions prevents the development of living matter? No change has occurred in the solutions which can be shown to prevent matter developing into living forms, and that being so, we are led to decide that Abiogenesis does not occur at the present day. Nor do we see reason for Professor Huxley's expectation already quoted; seeing, that, unless the existence of a lawgiver be granted, on which Professor Huxley is silent,—we must conclude that the laws governing matter were the same at the period referred to as at the present day; and this being so, if it were possible to transport our boiled solutions to such a distant period, we should find that they would remain the same as at present, no forms of life appearing in them. The same lime of argument holds good against the expectation that living matter may be produced from brute matter at any time in the future. Pressing our argument still further we are led to the conclusion that, since dead matter cannot of itself develop living matter, and since life was and is developed, there was, and is, a lawgiver and a lifegiver.

15. Leaving this point of the origin, and passing to our other point—the conditions essential to life—we are led to notice a remarkable conclusion recently arrived at by Professor Frankland. This eminent chemist comes to the conclusion, from a series of experiments on effluent sewage-water, and on water for domestic purposes (see Chemical News, vol. xxiii., pp. 67 and 78, January, 1871, for the paper on "The Development of Fungi in Potable Waters"), that the statement of the German philosopher who said "Ohne Phosphor kein Gedanke"—(There is no thought without phosphorus), may warrantably be altered to "Ohne phosphor gar kein Leben"—(There is no life without phosphorus). If this conclusion can be correct, it follows that the solutions before you which have developed fungi contained phosphorus in some form or other, which has admitted of the growth of the fungi, and since boiling was the only difference (in nearly all cases) in the treatment of the solutions, the boiled solutions must contain it as well. If this be so, we arrive at a conclusion which is again in favour of the Biogenesis theory; this is, that since the conditions essential to life are complied with by the solutions, and yet no life is developed, the living matter present in the solutions before being boiled has its life destroyed by the ebullition.

16. Moreover, these solutions become the means whereby to test the truth or falsity of Professor Frankland's conclusion, and I intend, in a few days, to put it to the test of experiment (see Appendix). In order that you may understand the plan on which I intend to proceed, it will be necessary for me first to lay before you, as briefly as possible, the mode of experiment followed by Professor Frankland. He took a quantity of water as supplied to the metropolis for domestic purposes, and added to it a quantity of sugar; the water was then allowed to stand for a week or ten days to see if fungi developed, if not the absence of phosphorus was shown, and, consequently, it was necessary to add it to the water in some form or other, in order that these low forms of life might grow in the weak sugar solutions. He thus found that phosphorus in some form was essential to the development of these fungi, and from this he concludes that it is essential to life. You will now be prepared for the plan which I have devised as the *experimentum crucis* on this point. I have here two pint stoppered bottles filled with Middlesbrough water; to the water in the one marked A, 5 grammes of pounded loaf-sugar were added, when drawn, on the 18th of February; to the one marked B, the same quantity of sugar was added, and 5 grms. of tartaric acid in addition —both solutions were then allowed to stand. If neither of them developes fungi, the conclusion must follow that neither of them contains phosphorus: if only B does, it will show that the tartaric acid added contains it, while, if both do, it will show that both contain it (though the quantity of fungi developed will probably show which contains most phosphorus), and will not necessarily indicate (unless, as has just been said, the quantity is greater), that the tartaric acid added does. If the last result is obtained, the experiment will have to be repeated with water free from phosphorus in order to obtain reliable results. As yet, as you see, no fungi have made their appearance. When the experiment is successful I shall have pleasure in laying the result before you (see Appendix).

17. I cannot sit down with remarking on the benefit I have derived from this course of experiments. I commenced them little thinking of the extent of bearing they would have on such important questions as those of the origin of, and conditions essential to, life; and, to my mind, it is only one more in the host of researches which, commenced in obscurity, and also having bearings apparently obscure, have eventually thrown light upon questions of the greatest moment. This of itself is a sufficient reward for the labour these experiments have entailed, and will stimulate me to further research on this and other kindred subjects (as well as others), to the end that truth may be increased; and in this search for scientific truth, I trust I shall not be alone in the host of members of the Cleveland Literary and Philosophical Society who are interested in science.

Appendix.

I.—Solutions referred to.—Particulars received from Halifax, March 20th, 1871.

Solution C. of August 12th, 1868.—Not mouldy. Liquid quite clear.

Solution No. 2, of September 21st, 1868.—Not mouldy. Solution clear and sparkling; bright particles float about when shaken.

II.—Results of experiments made February 18th, 1871, to determine whether tartaric acid contains phosphorus or not.

A. has developed a quantity of filmy brownish-white fungi. The solution is clear.

B. has developed a larger quantity of fungi, of a similar colour, but the form is somewhat globular. The solution is turbid.

From these results I conclude that the tartaric acid added either contained phosphorus or more living matter, which developed in a weak sugar solution. A further experiment with boiled solution of the acid will be necessary, in order to show which of the two conclusions is the correct one.

ON THE

DETERMINATION OF NITROUS ACID,

WITH SPECIAL REFERENCE TO THE

MANUFACTURE OF OIL OF VITRIOL.*

(Concluded from p. 239).

By W. CROWDER.

THE annexed tables are the result of a series of experiments in illustration:—

1st. Of the constancy of results obtained by the processes adopted.

2nd. A series of analyses of samples of nitrous and denitrated vitriol from four different works, illustrating the three different methods of denitrating, viz.:—

1st. By steam alone.

2nd. By a mixture of steam and sulphurous acid.

3rd. By passing nitrous vitriol down a column, and denitrating it by the hot sulphurous acid as it comes from the burners, which also concentrates the acid at the same time.

ANALYSIS OF VARIOUS SAMPLES OF NITROUS VITRIOL BY THE UREA AND PERMANGANATE PROCESSES, OBTAINED FROM FOUR ACID WORKS ON THE TYNE.

First Works—Acid Denitrated by Steam alone.

	Sp. gr. °Tw.	By the urea process.	By the permanganate process.
Acid condensed in burner pipes before entering the chambers	150	2·03	—
Nitrous acid from the cisterns	148	—	1·04
Ditto	,,	—	1·62
Ditto	,,	—	1·05
Ditto	,,	—	0·83
Ditto	,,	—	0·82
Ditto as it ran into denitrators (No. 1 set)	150	—	0·98
Ditto as it ran out after denitration by steam	132	—	0·16
Ditto as it ran into denitrators (No. 2 set)	150	—	1·12
Ditto as it ran out after denitration by steam	126	—	0·33
Ditto collected as it flows from absorbing columns (No. 1)..	148	—	1·16
Ditto collected as it flows from absorbing columns (No. 2)..	148	—	1·03
Ditto from the concentrating pans	150	—	0·14

Experiments Showing the Absorption which takes place in Passing through Columns.

Total height of absorbing columns 22 feet.

			Sp. gr. °Tw.	By urea process.	Absorption.
1st Expt.	1.	Nitrous strength of acid poured into column..	150	0·212	1·733
		Ditto as it ran out ..	,,	1·945	
	2.	Nitrous strength of acid poured into column..	,,	1·170	0·593
		Ditto as it ran out ..	,,	1·763	
	3.	Nitrous strength of acid poured into column..	,,	1·124	1·011
		Ditto as it ran out ..	,,	2·135	
2nd Expt.	1.	Nitrous strength of acid poured into column..	,,	1·033	0·730
		Ditto as it ran out ..	,,	1·763	
	2.	Nitrous strength of acid poured into column..	,,	1·778	1·312
		Ditto as it ran out ..	,,	2·090	
	3.	Nitrous strength of acid poured into column..	,,	2·254	0·248
		Ditto as it ran out ..	,,	2·492	

* Read before the Newcastle-upon-Tyne Chemical Society.

Second Works—Acid Denitrated by Steam alone.

Nitrate and denitrated acid.

Total height of absorbing columns, 45 feet.

	Sp. gr. °Tw.	By the urea process.	Repeated.	Repeated.	Repeated.
No. 1. From the concentrating pans	151	0·18	—	—	—
No. 2. Ditto after passing through the columns; analysis performed by Dr. Hess	148	3·02	3·08	—	—
The same sample, analysis performed by W. Crowder	—	3·16	—	—	—
No. 3. Another sample, by urea process, after passing through the column ..	149	2·62	2·60	2·63	2·35
The same, by permanganate standardised by a sample of nitrous vitriol, tested by urea process	—	2·73	2·73	—	—
Result in NO_3 calculated by amount of oxidation ..	—	—	1·66	—	—
No. 4. Another sample, tested permanganate as before..	149	2·81	2·84	—	—
Result in NO_3 by oxidation	—	—	1·77	—	—

Third Works—Acid Denitrated by a Mixture of Steam and Sulphurous Acid.

Nitrated and denitrated acid.

Height of absorbing column, 35 feet.

	Tested with permanganate
No. 1. Acid from absorbing columns— Sp. gr. 143° Tw., by oxidation process ..	0·444
No. 2. Denitrated acid (by steam and SO_2) Sp. gr. 123° Tw.	0·044
No. 3. Acid from absorbing columns .. Sp. gr. 142° Tw.	0·429
No. 4. Denitrated acid (by steam and SO_2) Sp. gr. 121° Tw.	0·026

Fourth Works—Acid Denitrated by Sulphurous Acid.

Nitrated and denitrated acid.

			Sp. gr. °Tw.	By permanganate. Per cent.	Result in NO_3 calculated by amount of oxidation. Repeated.
1st Expt.	No. 1.	Denitrated acid	153	0·15	0·17
	No. 2.	Acid from absorbing columns	151	0·96	0·92
	No. 3.	,, ,, ,,	152	0·58	0·63

		Sp. gr.	By urea Calculation.	Calculated by Oxidation.
No. 1.	Denitrated acid	153	0·27	0·164
No. 2.	Acid from absorbing columns	150	1·37	0·836
No. 3.	,, ,, ,,	151	0·76	0·461
No. 1 (*a*).	Denitrated acid	153	—	0·170
No. 2 (*a*).	Acid from absorbing columns	151	—	0·825
No. 3 (*a*).	,, ,, ,,	152	—	0·452

NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

IV.

IT will be convenient to pass over active principles and colouring matters, &c., considering them as they occur in their respective tissues and fluids. Non-nitrogenous matters will occupy our attention, as sugars, fats, &c.

Sugars Occurring in Animal Tissues.—Lactose in milk, glucose in urine, inosin in muscles, and glycocine, not as such, but as hippuric acid, which, as mentioned previously, is glycocine with an atom of H displaced by the radical benzoyl.

Lactose, or sugar of milk ($C_{12}H_{24}O_{12}$), is found exclusively in milk; it is secreted in the largest quantities by Herbivora, but also by animals fed exclusively on meat; it is a hard gritty body, crystallising in four-sided prisms, terminating in four-sided pyramids; sparingly soluble in cold water (5 parts), thus accounting for its inferior sweetening property; it turns a ray of polarised light to the right, is not fermentable, may be converted to galactose by boiling with acids; this is a fermentable variety, reduces copper salts in an alkaline solution, and combines with bases to form definite compounds. Lactose may be prepared by removing the casein from milk and evaporating the whey until crystals form.

Cow's milk contains 4 per cent, human milk 7 per cent of lactose; thus a few grains of lactose added to cow's milk approximates its composition to that of human milk.

Glu cose, or grape sugar ($C_6H_{12}O_6,H_2O$), occurs in the urine of diabetic patients as dextrose; its sweetening power is not so great as that of cane sugar; the variety from urine does not crystallise; it is dissolved but sparingly by alcohol; H_2SO_4 converts it to sulphosaccharic acid; KHO converts it to melassic acid; copper salts in alkaline solutions when boiled are reduced by glucose; it is also readily fermentable. A saturated solution of NaCl mixed with a solution of glucose crystallises in cubes ($NaCl,H_2O,2C_6H_{12}O_6$).

The frequent occurrence of sugar in the urine has led to the use of various tests, some of which are anything but reliable.

Runge's Test.—A film of the suspected fluid is evaporated to dryness on a porcelain dish and H_2SO_4 added; if sugar be present it is charred by the acid. It is asserted that albumen gives the same result; this is true to a certain extent, the charring is not so definite.

Trommer's Test.—This consists in adding to a portion of suspected fluid an equal bulk of *liq. potassæ*, and a few drops of solution of $CuSO_4$; the hydrated oxide of copper is thrown down; this is reduced to the suboxide, Cu_2O, on boiling if sugar be present.

Fehling's or Barreswil's Test.—This is a modification of the above, the potassic-cupric-tartrate being used instead of the $KHO+CuSO_4$.

The Copper Test serves not only as a qualitative but as a quantitative test for sugar; thus, if you have a volumetric solution of copper salt, made as directed in Mr. Sutton's "Volumetric Analysis," the estimation of the amount of sugar is readily made. A measured quantity of urine known to contain sugar is taken and heated in a porcelain dish; into this while boiling the copper solution is slowly discharged from a burette properly graduated; as soon as the urine becomes blue, the whole of the sugar has been expended in reducing the copper salt. The number of divisions of the volumetric solution used represents the amount of sugar in the known quantity of urine; this multiplied by the total quantity excreted in twenty-four hours gives the amount of sugar passed in that time.

Fermentation Test.—This perhaps is the best test of quantity, as it is most readily performed. Into a tube filled with mercury and inverted in a vessel full of the same metal is passed a measured quantity of saccharine urine, and with it a small piece of yeast; the whole thing is then left for twelve hours; at the end of that time the sugar will have been converted into CO_2 and H_2O; the first being a gas ascends and displaces the mercury. Every cubic inch of CO_2 thus formed represents about 1 grain of sugar, or more exactly 100 cubic inches represent 106·6 grains of sugar; the same rule as before gives the quantity passed in twenty-four hours.

The growth of *Torula*, a species of confervoid vegetation, is said to be characteristic of the presence of sugar. The presence of sugar in the blood has not been satisfactorily accounted for.

Inosin, or muscle sugar, is not of sufficient import to demand attention; of glycocine we have already spoken.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 16th, 1871.

Professor Odling, F.R.S., Vice-President, in the Chair.

After the minutes of the previous meeting had been read and confirmed, and the donations to the Society announced, the names of the following gentlemen were read for the first time:—Christopher Childs, William W. Abney, Jonathan Ingle Calvert, and Frederick J. Montague Page.

For the second time—William Gray, Frederick Hicks, Robert Irvine, Samuel William Moore, Donald Munroe, Hugh Paterson, Benjamin Tanner, Charles Thomas, William John Wilson, George Joseph Warner, and Reginald C. Woodcock.

The Secretary then read a paper "*On Burnt Iron and Steel*," by W. H. Johnson, B.Sc. In it the author expresses his opinion that the burning of iron and steel is not due to the action of uncombined oxygen. It would appear Mr. Williams thinks this to be the case from his paper, an abstract of which appeared in the *Journal of the Chemical Society*, but the oxygen does not exist in a free state in the hottest part of the furnace, as it is there united with carbon, forming carbonic acid and carbonic oxide. After referring to Mr. Lowthian Bell's experiments on the oxidising effect of carbonic acid, and the reducing action of carbonic oxide on iron at different temperatures, the author draws attention to the fact, that immediately the oxidising effect of the carbonic acid present becomes greater than the opposite action of the carbonic oxide, the iron begins to burn. The relative proportion of the two gases at which the point of equilibrium occurs varies greatly with the temperature; the higher this is, the smaller is the proportion of carbonic acid in the mixed gases necessary to produce the injurious effect; it takes place, moreover, with greater readiness when a comparatively pure iron is employed than with one containing sulphur or silicon. As red-hot iron is permeable to carbonic acid and carbonic oxide, their action is not confined merely to the surface, but penetrates into its substance. This induces the author to believe that the well-known increase of bulk which takes place when iron is repeatedly heated, is due to the formation of an oxide in the body of the metal, thereby increasing both its volume and its weight.

Dr. Odling said that, although the Society but seldom received papers of an argumentative character, the thanks of the members were due to the author for his observations on this important subject. The relation between the burning of iron and steel, and the experiments of Mr. Lowthian Bell on the varying oxidising power of carbonic acid at different temperatures and the corresponding reducing action of carbonic oxide, was of great interest, showing that there was a point at which these actions going on at the same time, so to speak, neutralised one another.

Mr. E. Riley said that it was quite as important to consider the mechanical treatment to which iron was subjected as the chemical reactions which took place; for instance, when iron which is so brittle as to be quite useless is piled two or three times it acquires, to a greater or less degree, a fibrous texture, whilst the very best iron, when melted in a crucible, yields a button which works very well under the hammer, but is otherwise quite changed, having become red-short. Great misconception

also existed as to the injurious action of many substances usually supposed to be prejudicial to the good quality of iron and steel. Iron containing silicon, for example, was difficult to puddle, but in steel its presence in small quantity was decidedly advantageous.

Dr. Odling asked whether he included phosphorus and sulphur amongst these substances.

Mr. Riley replied that the presence of phosphorus was certainly beneficial in some cases; Swedish iron puddled, is red-short, but when mixed with the proper proportion of Cleveland iron containing phosphorus, it yields an excellent iron. Lowmoor iron and the Yorkshire pig made from clay ironstone usually contain about 0·64 per cent of phosphorus, and the amount seemed to be the same whether the hot or cold blast were employed. Steel containing 0·1 per cent of phosphorus was bad, but he did not agree with those who say that the presence of silicon in steel is injurious. Silicon is necessary in the Bessemer process, and the best pig-iron sometimes contains a considerable quantity of it, the speaker having in his possession a piece of very superior quality which has as much as 2 per cent. Tungsten also may exist in very large proportion in steel; he had a specimen of very hard and most excellent steel which contained more than 10 per cent of it.

Dr. Muller asked whether the so-called Mushet's "titanium steel" contained titanium, as he had been unable to detect any in a sample he had examined.

Mr. Riley said that he had never found titanium in any white iron, and believed that it occurred only in grey iron.

Mr. F. W. Hart then described an improved syphon, consisting of an ordinary syphon having a globe at the bend furnished with a short vertical tube. The latter serves the purpose of starting the syphon, whilst the globe retains any gas that might be given off from the liquid, and which in an ordinary syphon would fill the bend and stop its action. A filter, consisting of an inverted funnel furnished with a perforated disk and covered with a layer of cotton wool or other suitable material can be attached to the shorter leg of the syphon.

Professor McLeod observed that the instrument was not new to him, as he had seen one of very similar construction in use some five or six years ago in the laboratory of the Royal Institution.

Mr. Hart stated that it was now about five years since he had first made one of these syphons, and, as far as he had been able to ascertain, no account of it had yet been published.

Dr. Vernon Harcourt said that he had had a syphon in use for a considerable time precisely similar to the one described. It is employed to maintain a constant level in the still of a distilled water apparatus, by supplying it with warm water from the worm tub of the condenser.

The Chairman then announced the adjournment of the meeting until Thursday, December 7, when a paper would be read by Dr. Gladstone "*On Essential Oils.*"

GLASGOW PHILOSOPHICAL SOCIETY.

(Chemical Section).

The business of the Section was resumed on the evening of Monday, the 6th inst., when Dr. W. Wallace, F.R.S.E., F.C.S., the President, delivered the opening address, which was occupied with a brief notice of certain topics of local interest, including the arrangements in the chemical department of the new buildings of the University of Glasgow, the appointment of Prof. Gustav Bischof to the Young Chair of Technical Chemistry in Anderson's University, the statue of the late Master of the Mint to be erected in Glasgow at the expense of Mr. James Young, and the disposal of the sewage, especially referring to Mr. Stanford's system of using seaweed charcoal as a deodorant of human excreta, and Mr. Gavin Chapman's method of utilising the urine from the public urinals of Glasgow.

Dr. Wallace also referred to the raid which parochial Boards in Scotland are making at the instigation of the Board of supervision in Edinburgh against the well-waters that are found to contain sewage contaminations. His large experience in analysing the waters of towns and villages justified him in saying that at least two-thirds of such waters are unfit for domestic use. In connection with this subject, he took notice of the evidence given by Dr. Letheby on the Edinburgh Water Bill last session, particularly in respect of the unhealthy character of soft waters, such as those supplied to Glasgow, Manchester, and other large towns where the mortality rates are high, and quoted from Mr. Bateman some remarks as a sort of reply to Dr. Letheby. Dr. Wallace considered that the more scientific physicians were the only persons who were competent to express opinions upon the subject, and he hoped they would inquire into it. Of the recent improvements in the alkali trade, Dr. Wallace spoke of and enlarged upon Weldon's process for regenerating manganese, Deacon's chlorine process, and Hargreaves's process for decomposing common salt by sulphurous acid. In metallurgical chemistry he referred to the difficulty and expense of making spiegeleisen for the Bessemer steel process, expressing his belief that ere long a suitable iron ore for this alloy would be got in Ireland in large quantity; to the splendid manganese colours obtained by Mr. Rowan, a member of the section; to Mr. Ferrie's self-coking blast-furnace; and to the introduction of the manufacture of zinc into Scotland. Mr. Spence's process of treating mineral phosphates in the manufacture of artificial manures was noticed, and so likewise were various topics connected with the subject of artificial lighting, and one or two others. The address was in every sense a most comprehensive and interesting one.

November 20th, 1871.

The annual meeting of the same section was held this evening, Dr. Wallace, the President, in the chair. After the transactions of some formal business, the election of the office-bearers of the section was proceeded with. As re-constituted the council consists of:—

President—Dr. William Wallace, F.R.S.E., F.C.S.

Vice-Presidents—Messrs. John Ferguson, M.A.; John Jex Long; W. R. Hutton.

Treasurer—Mr. P. M. Moir.

Secretary—Mr. R. R. Tatlock, F.R.S.E., F.C.S.

Other Members of Council—Dr. John Clark; Messrs. James Anderson; J. Couper; John Sutherland; James Mactear, F.C.S.; T. L. Paterson, F.C.S.; Alexander Whitelaw.

Before the meeting separated the President announced that a number of important papers had been promised for the ensuing session from Dr. Clark, Dr. T. E. Thorpe, Professor Bischof, and other members and associates of the section.

CORRESPONDENCE.

RELATION OF HEAT TO ELECTRICITY.

To the Editor of the Chemical News.

Sir,—It is generally said that the heat produced by a current of electricity varies as the square of the current (with the same resistance). I have no doubt that this is true in the cases from which the rule has been deduced, namely, where the sources of the electricity have been the same.

The following experiment would tend to throw a doubt on the general truth of the rule where the electricity is derived from different sources:—

I took two elements, one of zinc-platinum, and the other of iron-carbon, with the same electrolyte. The current from the former was 87° on a tangent galvanometer, of the latter 85°; consequently, the heating effects of the two currents ought to have been as the squares of the tangents of those angles, or about as 36 to 13; yet, on trial, I found the former would keep only about 12½ inches of a platinum wire red-hot, whilst the latter would keep 24½ inches of the same wire red; also in deflagrating different gauges of iron wire, I found that the latter would deflagrate like tow wire, which the former would keep scarcely red-hot. The sparks from the latter were also much more brilliant than from the former, emitting bright flashes and scintillations when a copper wire was rubbed along the rough edge of a rusty piece of iron.

The subject is worth investigation, and I venture, through your columns, to call the attention of scientific men to the point.—I am, &c.,

H. Highton.

2, The Cedars, Putney,
Nov. 18, 1871.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the Chemical News, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

Note. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, October 30, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Thermical Researches on the Electrolysis of the Alkaline Bases and Alkaline Sulphates.—P. A. Favre.—The continuation of a very lengthy and exhaustive memoir on this subject.

Idocrase from Arendal in Norway.—A. Damour.—The sp. gr. of this mineral = 3·44; it is harder than felspar, fuses by the action of the blowpipe flame, is readily acted upon by acids, and consists, in 100 parts, of:—Silica, 36·32; alumina, 16·70; lime, 34·86; protoxide of iron, 0·6; protoxide of manganese, 0·14; magnesia, 0·07; water, 0·25. Formula, $18(CaO,FeO,MnO,MgO)+4Al_2O_3+15SiO_3$.

Analysis of a Mexican Grenate.—A. Damour.—The specimen alluded to was obtained from a locality, Rancho de San-Juan, where a crystalline limestone is the prevailing rock. The sample was crystalline; colour, pale rose-red; hardness, greater than quartz; sp. gr. = 3·57; readily fusible before the blowpipe flame, forming a semi-transparent yellow-brownish glass. When fused in the reduction-flame along with borax, the mineral yields a colourless glass. The grenate is slowly acted upon by acids, but readily dissolved by these, after having been first ignited to redness in a platinum crucible. Composition, in 100 parts:—Silica, 39·46; alumina, 21·69; peroxide of iron, 1·36; lime, 35·75; magnesia, 0·67; protoxide of manganese, 0·96; volatile matter, 0·4.

Note on the Use of Dynamite.—M. Barbe.—The contents of this paper may be summarised by stating that the author has given a very complete review of the various uses to which dynamite may be applied, while setting forth the great superiority of this explosive material over gunpowder, also as regards greater safety against accident. It appears that dynamite is manufactured in France in very large quantities, and is also rendered applicable for military artillery purposes.

Conversion of Cane Sugar in the State of Solution into Glucose under the Influence of Light.—E. M. Raoult.—The author placed, on May 10 last, a concentrated solution of sugar in water in glass tubes, and, while boiling the same, sealed the tubes; these were placed close to each other in the same locality and under identically the same conditions, with the exception that one of the tubes was kept completely in the dark, the other tube being exposed to bright daylight. On October 20 last the tubes were opened, and the contents examined. The solutions were perfectly clear, and did not, on being microscopically examined, exhibit the least trace of vegetable matter. The fluid in the tube exposed to light yielded an abundant red-coloured precipitate with the cupro-potassic reagent, thereby indicating the presence of glucose, while the contents of the tube kept in complete darkness did not manifest that reaction at all.

Continuation of the Thermo-Chemical Researches on Ammoniacal Salts.—Dr. Berthelot.

Spectra of Phosphorus and of Silicium Compounds.—G. Salet.

November 6, 1871.

This number contains the following original memoirs and papers relating to chemistry and collateral sciences:—

Mode of the Repartition of Potassa and Soda in Plants.—E. Peligot.—The fourth portion of a very lengthy and exhaustive chemico-agricultural essay; this part treats on the influence of common salt as occurring more particularly in soils of drained fen-lands and land recovered from the sea.

Thermical Researches on Electrolysis.—P. A. Favre.—The continuation and end of the very exhaustive memoir on this subject.

Observations on the Solubility of Chloride of Silver in Reference to the Recent Communication of M. Stas.—I. Pierre.—The author quotes some observations made by him, as far back as the year 1844, on the solubility of chloride of silver in strong hydrochloric acid, and the precipitation of the chloride by the subsequent addition of water, and also calls attention to the fact that boiling nitric acid may dissolve, and convert into nitrate of silver, the chloride alluded to.

Formation of Precipitates.—Dr. Berthelot.—A thermo-chemical essay divided into the following sections:—Formation of a solid compound; dehydration of precipitated compounds, lime, carbonate of lime, carbonate of magnesia, carbonates of iron and manganese, sulphates of lime, baryta, and strontia.

Detection of Hydrochloric Acid in Cases of Poisoning with that Acid.—J. Bouis.—After referring to the difficulty of detecting whether small quantities of the acid alluded to—always present, though in very minute quantity only, in the natural and healthy stomachic juices—are due to a poisonous dose, the author advises that the contents of the stomach to be tested should be first filtered through paper or fine muslin previously moistened with acetic acid, and that to the filtered liquid gold-leaf be added, and a few grains of chlorate of potassa. The mixture is then heated on a water-bath, and tested afterwards with protochloride of tin, to see whether any gold is dissolved; the substances to be tested should, however, first be tried for the presence of free nitric and sulphuric acids.

Journal de Pharmacie et de Chimie, September, 1871.

This number contains the following original papers and memoirs:—

Researches on the Action of the Substances which Aid the Decomposition of Chlorate of Potassa while Employed for the Preparation of Oxygen.—Dr. E. Baudrimont.—The continuation and end of this lengthy memoir. This portion contains the following sections:—Influence of the nature of the bodies present with the chlorate of potassa—the bodies experimented with are:—Spongy platinum, red oxide of mercury, oxide of silver, permanganate of potassa, black oxide of copper prepared by the moist way, native peroxide of manganese, peroxide of iron, protosesquioxide of manganese, black oxide of cobalt, peroxide of lead, oxide of aluminium; influence of the state of division of these substances; influence of the temperature; study on the chemical action which certain substances exert upon chlorate of potassa; on the action of contact; on the origin of the chlorine with which the oxygen is contaminated; is the oxygen evolved from chlorate of potassa in the state of ozone? observations on the fusion of chlorate of potassa when an active substance has been added thereto.

Differences which the Divers Processes for the Estimation of Cream of Tartar Exhibit.—P. Carles.—The contents of this paper record a few experiments made by the author with the view to prove that the estimation of cream of tartar (bitartrate of potassa) in wines, when the salt alluded to is precipitated from that liquid by the aid of a mixture of alcohol and ether, may, as compared with the method of calcination (after evaporating the wine to dryness, and calculating the weight of the carbonate of potassa obtained as representing bitartrate of that base), lead to great differences of result, due to the presence in some kinds of wine of other organic potassa salts which are not precipitated by a mixture of alcohol and ether. The contents of this paper are of particular value to wine-growers; that the difference alluded to is not small may be inferred, for instance, from the fact, that in a sample of Malaga wine, the precipitation process only yielded 0·95 and the calcination process 3·40 parts per litre of bitartrate of potassa, a quantity too large to be held in solution in the wine as an alcohol-containing liquid.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, September, 1871

The following original papers are contained in this number:—

Antidotes to Poisoning with Carbolic Acid.—Dr. T. Husemann.—An interesting chemico-therapeutical essay, in which the author recommends, upon sound practical and experimentally-proved grounds, the use of a strong solution of saccharate of lime as an antidote against poisoning with carbolic acid, when by accident taken internally.

Practical Observations on Essential Oil of Mustard Seed.—Dr. F. A. Flückiger.—The contents of this essay may be *resumed* as follows:—When to the essential oil of mustard seed 3 parts of concentrated sulphuric acid are slowly and gradually added, care being taken to cool the mixture, sulphurous acid and sulphocarbonic oxide are evolved after twelve hours' standing. The mixture should either be clear yet very thick, or entirely converted into a crystalline mass; the mixture should then exhibit no longer the peculiar odour of oil of mustard seed, but, in addition to a slight smell of sulphurous acid, that of leek. The colour of the mixture should not be turned dark; when a parts of the essential oil

are mixed with 1 of absolute alcohol and from 6 to 8 of strong liquid ammonia, and heated to 50° for some time, the result should be that, on cooling in open shallow vessels, the mass becomes crystalline (formation of thiosinammin); the mother-liquor from these crystals should leave, by spontaneous evaporation, crystals, but hardly any fluid, which should scarcely, moreover, exhibit the smell of leek. These reactions, along with the specific gravity, characterise mustard seed oil very distinctly.

Les Mondes, November 9, 1871.

Telegraphic Rockets.—M. Papafy.—The author has devised a series of sky-rockets (fireworks) adapted for telegraphic service at night for armies when in the field, so arranged that each rocket is, by a variation of coloured light, capable of transmitting six words, visible at a distance of 32 kilometers = 19·872 English miles. These signals can be readily kept unintelligible to the enemy, while everything relating to military and strategical matters can be easily expressed. The Prussian War-Department has bought the secret of this invention from the author, a Hungarian in service as captain in the United States Army.

New Method of Stopping in a Very Short Space of Time an Express Railway Train.—Rev. Thirion.—Illustrated by woodcuts. The contents of this paper decidedly deserve the serious attention of railway-engineers and locomotive-engine builders.

November 16, 1871.

New Hydraulic Invention.—A. Joly.—The author has invented a simple mechanism (not further specified) by the aid of which the concussion (*coup de belier*) caused in water-conducting pipes by the sudden opening and closing of taps fitted to them, as well as the freezing of that liquid in the pipes, may be prevented.

Anhydrous and Hydrated Salts.—M. Favre.—All the crystallised anhydrous salts generate on being dissolved in water, cold, while the crystallised hydrated salts cause the evolution of heat, when becoming dissolved in water.

Chemical Laboratory at Neufchâtel (Switzerland).—Dr. Sacc.—From a short abstract, taken from the Report of the Cantonal Inspector of Public Instruction, here published, we learn that the laboratory, the property of the canton which bears the name of its chief town (above quoted), is every year becoming of greater importance. The collections of samples and specimens, minerals, ores, organic and inorganic compounds, instruments, and library, are almost daily added to either by the kind attention of donors interested in science, arts, and industry, or by purchase, and last, but not least, by the preparations made by the students who work there, their number being at present about ninety; most of these are foreigners to the Republic, the Government of which may be highly congratulated on the very favourable results its care has produced, as regards providing sound, effective, and cheap public instruction not only in respect of the high intellectual development of the inhabitants, but also of a very large number of foreigners. The regulations at Neufchâtel as regards those who desire to learn chemistry, both practical and theoretical, are such that the instruction may be said to be almost gratuitous.

Sitzungsberichte der Mathematisch-Physikalischen Classe der Königlich Bayerischen Akademie der Wissenschaften zu München, vol. i., 1871.

The original papers and memoirs relating to chemistry published in this volume are the following:—

Metamorphosis of Matter Observed in Cases of Poisoning with Phosphorus.—Dr. J. Bauer.—The contents of this lengthy memoir dwell on the peculiar effect of phosphorus, which results in an elimination of nitrogenous matters from the bodies of men and animals to whom large doses of this element are given, and the production of an excess of fat, due to an imperfect process of oxidation.

Geognostic Relation of the Ulm Cement Marl and its Affinity to Lithographic Stone, and the Foraminiferæ-Fauna which Accompany the Latter.—Dr. Gümbel.—This essay, accompanied by several engravings, treats on a peculiar kind of mineral met with near Ulm (Würtemberg), and used for the purpose of preparing hydraulic cement. The contents of this paper are strictly geognostical and palæontological.

Realisation of Certain Kinds of Ash-Constituents of the Animal Body.—Dr. Voit.—A physiologico-chemical essay on nutrition and on the action of certain inorganic constituents of the animal body in its embryo state.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, November 9, 1871.

Newly-Invented Ozone-Generating Apparatus.—M. Ruhmkorff.—The detailed description, elucidated by a woodcut, of a contrivance by the aid of which, under the influence of a very large number of electric sparks, air may be ozonised in a closed space, and the ozone so formed applied for use in chemical operations.

Apparatus for Measuring the Intensity of the Sun's Radiation.—Rev. Father Secchi, S.J.—This description is also illustrated by a woodcut.

Composition of Calorific Value of Two Samples of Welsh Coal.—M. Scheurer-Kestner and C. Meunier.—The coals alluded to are Bwlf and Powell.—The former consists, in 100 parts, of:—Water, 0·63; carbon, 87·48; hydrogen, 3·68; ash, 3·32; oxygen, 4·89; yields 82·08 per cent of a slightly caked coke; 1 kilo. of this coal evaporates 8·826 litres of water; calorific value = 8·780. The latter-named coal consists, in 100 parts, of:—Water, 0·75; carbon, 88·36; hydrogen, 3·80; ash, 3·72; oxygen, 3·31; yields 81·16 per cent of coke; 1 kilo. evaporates 9·076 litres of water; calorific value = 8·949. The authors, having been engaged for a considerable length of time in making researches on mineral fuel, have found that, as regards coal, the heat it yields by combustion exceeds that of the heat of all its constituent elements (when completely burnt) added together, while, as far as lignite is concerned, it appears that just the reverse obtains.

Continuation of the Tabulated Review of the Composition of Fertilising Substances which may be Added to Manures or are fit for Use as such by themselves.—C. Mène.—(See CHEMICAL NEWS, vol. xxiv., p. 182).

Bibliography.—Under this heading we find here short reviews of the two following books, lately published by MM. Hachette, viz.:—"Nôtre Planète," par M. J. Duval. This work treats more particularly on the relation existing between political economy and geography, and dwells at some length on anthropology as viewed in reference to recent discoveries. "Eléments de Zoologie," par Dr. P. Gervais. The second and greatly enlarged and improved edition of a work edited by one of the most competent scientific authorities on this subject in Europe. For clearness of views, and sound inductive treatment of the subject, this work deserves the attention of all who desire to obtain some knowledge in zoology.

La Revue des Scientifique de la France et de l'Etranger, October 28, 1871.

This number does not contain any original papers on chemistry, but we call attention to the excellent lecture:—

Phenomena of Respiration.—Dr. Gréhaut.—The continuation of this subject, illustrated by several woodcuts, and treating on the respiration of fishes, extraction of gas from blood, and on hemaglobine.

NOTES AND QUERIES.

Specific Gravity.—Would any of your readers kindly inform me of a method of finding the specific gravity of any liquid by Twaddle's hydrometer, from the lowest to the highest indications, and oblige a tyro.—J. W.

Refining and Bleaching Tallow.—Can any of your readers oblige me with the best and cheapest mode of refining and bleaching tallow for manufacturing purposes? A good colour is wanted.—B.S.O.

Gallic Acid.—Thanks to Hugo Tamm, but he has missed the purport of the enquiry; nor is it at all clear that "the two Hugo's agree splendidly together." If in conforming to a wide formula of genesis, tannic acid is a *di*-gallic acid, and tannin is a *tri*-gallic glucoside; then it is next to certain that the radical of gallic acid is ($C_{14}H_5O_8$), and such, I believe, it will be found in any future ammoniacal sulpho-acid, or other substitutional derivatives. Will "H. T" favour the enquirer with his address.—S. E. P.

Law of Compound Proportion.—In the CHEMICAL NEWS some time ago, I think I read a note saying, "That the law which used to be called of 'compound proportion' was not correct." Rather, the words took this form, "That the formula of a compound body cannot be called the 'equivalent' of that body." And it gave an example, naming a salt, and saying that the sum of its components were not the equivalent of that body capable of combining with any other named. Now, is this true, or how far is it true, that the equivalent of a compound is the sum of its components, *i.e.*, the sum of the equivalent of its components?—E. K.

Weighing Deliquescent Substances.—I do not know if I suggest a new detail, but, taking the benefit of the doubt, I wish to mention the following:—Having been repeatedly aggravated by the conduct of deliquesent substances in the balance, I selected a light beaker, and a bit of ground glass to cover it, and, grinding the edge of the beaker, which just admits the crucible, I find that I can weigh with all desirable deliberation, crucible, lid, beaker, and cover. I keep all in the desiccator, and of course know their weights. It is a great relief to my mind not to risk the accuracy of my weighing for the sake of speed.—MARSHALL HALL.

MEETINGS FOR THE WEEK.

MONDAY, Nov. 27th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "Smell, Taste, and Touch" (Course of Elementary Physiology).
—— Medical, 8.
—— Royal Geographical, 8·30.
TUESDAY, 28th.—Civil Engineers, 8.
WEDNESDAY, 29th.—Society of Arts, 8.
THURSDAY, 30th.—London Institution, 7.30. Mr. P. L. Simmonds, F.R.C.I., F.S.S., on "Science and Commerce Illustrated by the Raw Materials of our Manufactures (II.)."
—— Royal, 4. Anniversary.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 627.

CONTRIBUTIONS TO THE HISTORY OF THE OPIUM ALKALOIDS.*

By C. R. A. WRIGHT, D.Sc.,
Lecturer on Chemistry in St. Mary's Hospital Medical School.

PART III.

1. *Action of Hydriodic Acid on Codeia in Presence of Phosphorus.*

IN Parts I. and II. of these researches the action of hydrobromic acid on codeia and its derivatives has been partially investigated; and as the action of this acid appears to be in some respects similar to, but in others different from that of hydrochloric acid, it appeared to be of interest to examine the action of hydriodic acid also.

Some preliminary experiments on this subject made two or three years ago in conjunction with the late Dr. A. Matthiessen, showed that when codeia is boiled with a large excess of strong hydriodic acid, no appreciable quantity of methyl iodide is evolved even after some hours' treatment; a brown tarry mass containing much free iodine was produced, but at the time nothing fit for analysis was obtained from this; since then, Dr. Matthiessen and Mr. Burnside† have corroborated the non-formation of methyl iodide under these circumstances.

If, however, phosphorus be added simultaneously with the hydriodic acid, so as to prevent the accumulation of free iodine, methyl iodide is evolved at 100° and upwards in quantity close upon that required for the equation—

$$\underbrace{C_{18}H_{21}NO_3}_{\text{Codeia.}} + HI = CH_3I + \underbrace{C_{17}H_{19}NO_3}_{\text{Morphia.}};$$

hitherto, however, no body of this latter formula has been isolated from the products of the reaction, the substances ultimately formed being derived from a base containing H_2 more than morphia.

The hydriodic acid was obtained in the first instance by the action of hydric sulphide on iodide and water; in the dilute acid thus got iodine was dissolved, and the whole digested at a very gentle heat with phosphorus, more iodine solution being added from time to time; finally the whole was distilled several times from potassium iodide. A colourless acid of sp. gr. 1·7 to 1·75, and containing 50 to 55 per cent of HI was thus obtained, and preserved colourless by keeping a stick of phosphorus in the bottle. The codeia used in these experiments was part of a further supply most liberally presented by Messrs. Macfarlane, of Edinburgh.

On heating on the water-bath a mixture of 10 parts codeia, 30 to 50 of this acid, and 1 of phosphorus, the evolution of methyl iodide is noticed in a few minutes; simultaneously the liquid becomes brown, indicating the separation of free iodine; after two or three hours the brown colour disappears, and the evolution of methyl iodide ceases. If the liquid be heated to gentle ebullition, at first the same effects ensue, but more quickly; the resulting product, however, varies in composition according to the temperature at which the reaction was effected.

In one experiment 55 grms. of codeia yielded by condensation 22·5 grms. of methyl iodide, the theoretical yield being 24·6 from crystallised codeia, $C_{18}H_{21}NO_3,H_2O$; hence upwards of 90 per cent of the theoretical yield was obtained. In order to prove the elimination of 1-18th part of the carbon in the form of methyl iodide, 4·3045 grms. of codeia dried at 140° to 150° C., was heated to gentle ebullition with 30 grms. of 55 per cent of hydriodic acid and about 2 of phosphorus; the vapours evolved were passed through a flask to condense aqueous vapour, and then through a combustion-tube filled with red-hot lead chromate, the CO_2 produced being absorbed in the usual way, an aspirator being attached at the far end so as to create a diminished pressure throughout the apparatus, and thus guard against loss of methyl iodide vapour by leakage at any of the numerous corks and joints.* After three hours a current of pure oxygen was let through the apparatus to sweep out the last traces of methyl iodide vapour from the flasks, and ensure the perfect combustion of deposited carbonaceous particles.

4·3045 grs. codeia thus gave 0·617 grm. CO_2.
0·3720 grm. codeia, burnt in the usual way, gave 0·9830 CO_2.

	Found.	Calculated.
(A) Percentage of carbon evolved as CH_3I	3·91	4·013
(B) Percentage of carbon in codeia used	72·07	72·241
Ratio of A to B	$\frac{3·91}{72·07} = \frac{1}{18·4}$	$\frac{4·013}{72·241} = \frac{1}{18}$

In another experiment not carried to a complete conclusion, the CO_2 collected represented 3·7 per cent of the codeia used.

The methyl iodide produced was found, after washing with water, drying over $CaCl_2$, and distillation, to be free from traces of dissolved phosphorus, to boil at 42° to 45° C., and to correspond in every respect with the ordinary methyl iodide.

If the reaction with hydriodic acid takes place on the water-bath, the resulting product appears to have the composition $C_{68}H_{86}I_2N_4O_{12},4HI$: but if the mixture be heated to gentle ebullition throughout, the temperature not being allowed to exceed 110° to 115° from loss of aqueous fluid by evaporation, the substance obtained contains the elements of two molecules of water less, $= C_{68}H_{82}I_2N_4O_{10},4HI$; whilst if the mixture be rapidly boiled, so that by evaporation the boiling-point rises to 130° and upwards, the ultimate product contains less oxygen than this last body, being $C_{68}H_{82}I_2N_4O_6,4HI$. These three formulæ might each be halved; but inasmuch as compounds containing not less than C_{68} have been got from these products by simple treatments, the higher formulæ are more probable.

All three substances are, while moist, colourless tars, drying at 100° to brittle waxy-looking masses, not fusing at 100° when perfectly dry; they are soluble in hot water, a decomposition being thereby produced; while moist they appear to absorb oxygen with avidity, rapidly becoming yellow or orange. They are also extremely hygroscopic, and from the high percentage of iodine contained, the ease with which they decompose on heating, and the difficultly combustible carbon left, their analysis is a matter of some considerable difficulty. From all these circumstances combined, the numbers obtained do not always accord quite as closely as might be expected in the case of crystalline and easily purified substances.

To obtain the compound $C_{68}H_{86}I_2N_4O_{12},4HI$, 10 parts of codeia, 30 of 55 per cent hydriodic acid, and 1 of phosphorus may be heated on the water-bath for three to four hours, at the end of which time the evolution of methyl iodide has entirely ceased: by filtering the syrupy hot liquid through asbestos to separate particles of amorphous phosphorus and addition of a little water when cold, a colourless tar is precipitated, which soon sets to a hard brittle mass; this is broken up and thoroughly washed with water to separate the phosphorus acids produced simultaneously, and finally freed from moisture as far as possible by pressure between filter paper, and dried at 100°.

The same body may also be obtained by dissolving the original substance in slightly warm water, precipitating with sodium carbonate, and extraction of the mass thus thrown down with ether, and agitation of the first portions

* Read before the Royal Society, November 16, 1871.
† *Proceedings of the Royal Society*, vol. xix., p. 71.

* This device may be applied with advantage to the ordinary processes for combustion, blowing out of the tube as well as loss by traces of leakage being thus avoided.

of the ether extract with hydriodic acid: the tar thus got is identical in all respects with the original substance. After drying at 100° the following numbers were obtained:*—

(A) Prepared by the first method:—
0·3785 grm. gave 0·588 CO_2 and 0·173 H_2O.
0·359 grm. gave 0·2535 AgI.

(B) Prepared by ether process:—
0·357 grm. gave 0·5655 CO_2 and 0·165 H_2O.
0·2635 grm. gave 0·1895 AgI.

(C) Another specimen prepared by ether process:—
0·316 grm. gave 0·493 CO_2 and 0·135 H_2O.
0·2865 grm. gave 0·2025 AgI.

	Calculated.		Found.			
			A.	B.	C.	Mean.
C_{68}	816	42·59	42·36	43·20	42·54	42·70
H_{90}	90	4·70	5·08	5·14	4·75	4·99
I_6	762	39·77	38·16	38·87	38·19	38·41
N_4	56	2·92				
O_{12}	192	10·02				
	1916	100·00				

$C_{68}H_{86}I_2N_4O_{12},4HI$.

The falling short in the percentage of iodine found in these specimens is readily accounted for by the action of the water which necessarily adheres to the tarry product got by either of the above processes; it will be subsequently shown that by the action of water on this body the elements of HI are removed from it.

This compound is apparently formed by the reaction—

$$\underbrace{4(C_{18}H_{21}NO_3,HI)}_{\text{Codeia hydriodate.}}+14HI=$$

$$=4CH_3I+I_8+\underbrace{C_{68}H_{86}I_2N_2O_{12},4HI.}_{\text{New body.}}$$

The iodine thus set free is, of course, re-converted into HI by the action of the phosphorus, a mixture of phosphorous and phosphoric acids being thereby produced. The reaction,

$$3I_2+P_2+6H_2O=2H_3PO_3+6HI,$$

requires for 50 grms. of codeia 3·45 grms. of phosphorus to be converted into phosphorous acid; whilst the equation $5I_2+P_2+8H_2O=2H_3PO_4+8HI$ requires 2·07 grms. to be converted into phosphoric acid. In one experiment 2·8 grms. of phosphorus, as nearly as could be estimated, were found to have become converted into the mixture of the two acids, 50 grms. of codeia having been employed.

On attempting to procure the free base $C_{68}H_{86}I_2N_2O_{12}$ from the hydriodate got as above, by precipitation with sodium carbonate, a snow-white mass was obtained containing, besides a small quantity of the desired base (soluble in ether), a large quantity of two other bases derived from this one (but sparingly soluble in ether). The description of the products thus got will be given in a subsequent section.

By treating codeia with hydriodic acid and phosphorus as above described, but at a temperature of gentle ebullition, not rising above 115°, a product is got on filtration through asbestos and precipitation by water containing apparently $2H_2O$ less than the preceding compound. Dried at 100°,

0·302 grm. gave 0·475 CO_2 and 0·135 H_2O.
0·248 grms. gave 0·1845 AgI.

	Calculated.		Found.
C_{68}	816	43·40	42·89
H_{86}	86	4·58	4·97
I_6	762	40·53	40·20
N_4	56	2·98	
O_{10}	160	8·51	
$C_{68}H_{82}I_2N_4O_{10},4HI$	1880	100·00	

* All combustions given in this paper were made with lead chromate and oxygen; and the iodine determinations by boiling with nitric acid and silver nitrate.

Hence this substance is formed from the preceding one by the reaction—

$$C_{68}H_{86}I_2N_4O_{12},4HI=2H_2O+C_{68}H_{82}I_2N_4O_{10},4HI.$$

If codeia, hydriodic acid (3 to 5 parts), and phosphorus be heated to rapid ebullition, so that most of the aqueous portion distils off along with the CH_3I formed, the boiling-point gradually rises to 130°, or a little above, at which temperature the colourless liquid begins again to become slightly brown; on precipitation of the filtered product with water &c., as before, the following numbers were obtained after drying at 100°.

Specimen A. 0·3575 grm. gave 0·589 CO_2 and 0·168 H_2O.
0·402 ,, 0·307 AgI.
Specimen B. 0·358 ,, 0·583 CO_2 and 0·164 H_2O.
0·369 ,, 0·2815 AgI.
Specimen C. 0·3855 ,, 0·635 CO_2 and 0·178 H_2O.
0·363 ,, 0·276 AgI.

	Calculated.		Found.			
			A.	B.	C.	Mean.
C_{68}	816	44·93	44·92	44·41	44·91	44·75
H_{86}	86	4·73	5·22	5·09	5·13	5·15
I_6	762	41·96	41·27	41·23	41·09	41·20
N_4	56	3·09				
O_6	96	5·29				
	1816	100·00				

$C_{68}H_{82}I_2N_4O_{6,4}HI$

Hence this substance is formed from the preceding one by the reaction—

$$C_{68}H_{82}I_2N_4O_{10},4HI+8HI=$$
$$=I_8+4H_2O+C_{68}H_{82}I_2N_4O_{6,4}HI.$$

2. Action of Water on the foregoing Compounds.

When either of the two first compounds just described is dissolved in a large bulk of hot water, and the solution allowed to cool, solid white flakes are obtained containing more C and H, and less I, than the original substance. By repeating this treatment several times successively, the same ultimate compound appears to be produced in each case, being apparently formed by the reactions—

$C_{68}H_{86}I_2N_4O_{12},4HI = 2HI+2H_2O+C_{68}H_{80}N_4O_{10},4HI$,
$C_{68}H_{82}I_2N_4O_{10},4HI = 2HI+C_{69}H_{80}N_4O_{10},4HI$.

The removal of the last traces of basic HI is very difficult; it may be accelerated by adding a few drops of sodium carbonate to the boiling solution and filtering hot from the small amount of precipitated base; the product is apt, however, to be more strongly yellow coloured when obtained in this way than when got by treatment with water alone.

Specimen A. Got from compound $C_{68}H_{82}I_2N_4O_{10},4HI$ by water and a little sodium carbonate:—
0·366 grm. gave 0·672 CO_2 and 0·177 H_2O.
0·406 grm. gave 0·227 AgI.

Specimen B. From same compound by water alone:—
0·369 grm. gave 0·674 CO_2 and 0·174 H_2O.
0·4555 grm. gave 0·2675 AgI.

Specimen C. From compound $C_{68}H_{86}I_2N_4O_{12}.4HI$ by water alone:—
0·4265 grm. gave 0·762 CO_2 and 0·220 H_2O.
0·3845 grm. gave 0·2275 AgI.

	Calculated.		Found.			
			A.	B.	C.	Mean.
C_{68}	816	50·25	50·08	49·81	48·73	49·54
H_{84}	84	5·17	5·36	5·24	5·73	5·41
N_4	56	3·45	—	—	—	—
O_{10}	160	9·85	—	—	—	—
I_4	508	31·28	30·21	31·74	31·98	31·31
	1624	100·00				

$C_{68}H_{80}N_4O_{10},4HI$.

Specimen A, dissolved in hot water and precipitated by sodium carbonate, yielded a yellowish-white substance,

rapidly becoming darker and finally almost black. Dried rapidly at 100°,—

0·370 grm. gave 0·930 CO and 0·235 H_2O.

About 0·5 grm. examined qualitatively for iodine gave only traces of AgI.

	Calculated.		Found.
C_{68}	816	68·46	68·55
H_{80}	80	6·71	7·05
N_4	56	4·70	
O_{15}	240	20·13	
$C_{68}H_{80}N_4O_{10}+O_5$	1192	100·00	

From these numbers it appears that the free base, like bromo- and chloro-tetra-codeia, rapidly absorbs oxygen from the air.

Probably there exists a compound intermediate between the hydriodate just described and the original body—

$$C_{68}H_{82}I_2N_4O_{10},4HI;$$

thus one batch of flakes got by two treatments with water of this original substance gave the following numbers after drying at 100°:—

0·3225 grm. gave 0·556 CO_2 and 0·153 H_2O.
0·3205 grm. gave 0·212 AgI.

Another specimen obtained similarly—
0·4175 grm. gave 0·269 AgI.

	Calculated.		Found.	
C_{68}	816	46·58	47·02	—
H_{85}	85	4·85	5·27	—
I_5	635	36·24	35·75	34·82
N_4	56	3·20		
O_{10}	160	9·13		
$C_{68}H_{81}IN_4O_{10},4HI$	1752	100·00		

It is not impossible that this substance is not a definite compound, but only a mixture; nevertheless, a free base of this composition and its hydriodate have been obtained by the action of sodium carbonate on the compound

$$C_{68}H_{86}I_2N_4O_{12}.4HI,$$

from whence it appears probable that the body analysed is really a definite compound, formed by the reaction.

$$C_{68}H_{86}I_2N_4O_{10},4HI = HI + C_{68}H_{81}IN_4O_{10},4HI.$$

Both the final and intermediate products have a very curious structure under the microscope; although they stimulate in a high degree the appearance of crystals as they separate from a hot aqueous solution, yet on microscopic examination they are found to consist of strings of coalesced globules not unlike the yeast-plant. In qualitative reactions all the bodies hitherto described are very similar: ferric chloride gives no colouration to the aqueous solution of the hydriodate; silver nitrate is reduced on standing, producing a yellow tint; nitric acid gives an intense yellow; sulphuric acid and potassium dichromate only separate iodine; sodium carbonate throws down a white precipitate scarcely soluble in excess, and soon becoming yellow, salmon-colour, and finally dark brown; ammonia gives a similar precipitate somewhat more soluble in excess, while caustic potash readily dissolves the white precipitate first formed. In many of these reactions this group of codeia derivatives utterly differs from the bodies got by the action of HCl or HBr; most of these latter derivatives give colours with ferric chloride and sulphuric acid and dichromate; all give a blood-red with nitric acid, while the free bases turn more or less *green* by exposure to air.

On similarly treating with boiling water the compound $C_{68}H_{82}I_2N_4O_6,4HI$, formed by the action of hydriodic acid on codeia at about 130°, a substance similar in characters to that got from the other two compounds is produced; the final product, however, differs somewhat in its physical characters from those just mentioned; instead of coming out from the hot aqueous solution in solid flakes, it appears in very minute solid oil globules which do not readily subside, and give to the liquid a great resemblance to fresh milk; sometimes the globules do not subside for many days.

Dried at 100° these globules give numbers indicating a compound analogous to that of the non-iodised base just described; it is, however, much more difficult in this instance to remove the last portions of basic HI; moreover, 4 molecules of water appear to be taken up, probably in lieu of the oxygen lost.

Specimen A. Original substance treated three times with large excess of water—
0·3315 grm. gave 0·589 CO_2 and 0·175 H_2O.
0·299 grm. gave 0·178 AgI.

Specimen B. Original with water four times—
0·321 grm. gave 0·585 CO_2 and 0·169 H_2O.
0·411 grm. gave 0·754 CO_2 and 0·218 H_2O.
0·2835 grm. gave 0·165 AgI.

Specimen C. Original with water five times—
0·4095 grm. gave 0·746 CO_2 and 0·219 H_2O.
0·3995 grm. gave 0·237 AgI.

		Calculated.		Found. A.	Found. B.		Found. C.	Mean.
C_{68} ..	816	50·00	48·46	49·71	50·03	49·68	49·47
H_{92} ..	92	5·64	5·87	5·85	5·89	5·94	5·89
I_4 ..	508	31·13	32·17	31·45		32·06	31·86
N_4 ..	56	3·43					
O_{10} ..	160	9·80					
	1632	100·00					

$C_{68}H_{88}N_4O_{10},4HI$.

Hence this compound is formed by the reaction

$$C_{68}H_{82}I_2N_4O_6,4HI + 4H_2O = 2HI + C_{68}H_{88}N_4O_{10}.4HI.$$

Carbonate of soda threw down from Specimen C. a white precipitate, becoming yellow on standing: this precipitate contained a small amount of iodine, showing (as the above numbers indicate) that the transformation of the original substance was not absolutely complete.

The qualitative reactions of this substance are the same as those of the bodies previously described.

(To be continued).

ON THE

ESTIMATION OF NITROUS ACID IN NITRO-SULPHURIC ACID.

By GEORGE E. DAVIS.

On page 237 of this journal, Mr. W. Crowder gives a most important and interesting paper upon a subject which must be of great interest to all those interested in technical chemistry. I allude to the paper "On the Estimation of Nitrous Acid in the Commercial Gay-Lussac Acid."

In the month of May last it was part of my work to estimate the amount of nitro-compounds in our acid from the absorbing column daily. A method was put into my hands (which was imported from the Tyne) which was as follows:—

There was a graduated tube or pouret, divided into 100 parts, and etched on the side was 363 grs. 20 grs. of a 35 per cent bleaching-powder was now ground up and mixed with about a pint of water in a large flask; the pouret was filled up to O with the nitrous vitriol and gradually added with constant agitation until a few drops of indigo sulphate produced a permanent blue colouration.

This is the process as I received it, but I found that it was very inconvenient to have to keep and to weigh off every time 20 grs. of the bleaching-powder, so I set to

work and prepared a solution of which 10 c.c. contained exactly 7 grs. of chlorine. On the day upon which I seriously thought of preparing a large quantity of standard solution I met with a sample of bleaching liquor which contained exactly 7 per cent of chlorine; I took of this 10,000 grs. and diluted it to a litre, and prepared a Winchester quart of the solution. The process then became exceedingly rapid, as it was not protracted by the process of weighing, and an estimation occupied about three minutes.

If the number of measures used varied from 60 to 70 the acid was considered very good. In the few spare moments I then possessed my thoughts were, "What do those numbers mean?" but my time being so fully occupied the matter received no attention until the first week in June, when I began to investigate the subject, as I was struck with the similarity of the numbers obtained when the same samples were operated upon, as specimens I give from my note-book.—

	Sample α.	Sample β.	Sample γ.
1st trial	97	74	103
2nd ,, ...	97	76	101
3rd ,, ...	99	76	102
4th ,, ...	98	78	102

Now, the process I have always used for the estimation of nitrous acid (N_2O_3) has been the permanganate process (see Fresenius's "Quantitative Analysis," 1870, p. 166), so I thought I would try this latter process and see if the numbers obtained corresponded at all with the chloride of lime figures. They did not closely correspond, and from pressure of other business I was forced to give the subject up for awhile. I had spoken to several chemists on the subject, and they all agreed with me that the permanganate process seemed the most reliable.

In pursuing the investigation in August, I first thought it necessary to determine whether the nitro-compounds were wholly in the form of nitrogen-trioxide, although my reading, and the assertions of other chemists, assured me that that point had been already determined. Having assured myself that the nitrogen-trioxide alone was present, I commenced to use my decinormal solution of potassium permanganate, but owing to the organic matter which colours the brown vitriol, the end of the reaction is not very definite, the pink colour always going after standing for a few minutes; but if the colour lasts for two minutes I think it may be taken that all the nitrous acid is oxidised.

For one week in August I put down the number of c.c. used to 10 c.c. of the nitrous vitriol, by the side of the number of divisions of vitriol used from the pouret by the chloride of lime method. They were as follows:—

Chloride of lime method.	Permanganate $\frac{N}{10}$ No. of c.c. used.
78	64
71	76
87	59
99	52
89	68
86	61

When these numbers come to be considered it will be seen that there are irregularities which I have found it difficult to explain; for instance, 78 measures contained the nitrous acid which the 20 grs. of bleaching-powder would oxidise, and also the 64 c.c. of the $\frac{N}{10}$ permanganate, whilst in another case that quantity of nitrous acid was contained in 89 divisions of the pouret and required 68 divisions or c.c. of permanganate to oxidise it.

Now, the organic matter which colours the brown oil of vitriol of commerce is partly destroyed by the acid of high density; in fact, the partial destruction forming the colour, and this is readily acted upon by the permanganate; not but what *all* brown vitriol contains organic matter, but some samples may contain a great deal more than others. Then, again, some vitriols may contain more arsenious compounds than others; but of course these would be equally acted upon by permanganate or chlorine.

Then there is another source of error in the permanganate process. It has been shown that a large excess of sulphuric acid interferes with the determination of iron by its use, and it might be supposed that a large quantity of acid would be injurious in this case; the dilution of the nitrous acid also affects the results.

I use the permanganate process thus:—

Take 10 c.c. of the nitrous vitriol and put it into a litre of water in a large flask and agitate it gently so that any nitrous acid which may be given off is again dissolved. This is again, I think, a source of error, for the nitrous acid is in contact with oxygen in the presence of water, and a slight oxidation might take place. When the solution has been prepared, the decinormal solution of permanganate is added until the solution is not decolourised after standing *two minutes*. This precaution was not taken in the experiments just cited, for the addition of permanganate was stopped directly immediate decolouration ceased, as I was afraid that the permanganate would be consumed by the organic matter.

Each c.c. of permanganate made by dissolving 3·162 grms. in the litre = 0·0019 grm. of nitrous acid (N_2O_3), the reaction which takes place being—

$$2K_2Mn_2O_8 + 6H_2SO_4 + 5N_2O_3 = 2K_2SO_4 + 4MnSO_4 + H_2O + 10HNO_3.$$

By following the above instructions results may be obtained which nearly coincide with the chloride of lime method. To return to this latter method. The reaction which takes place between chlorine and nitrous acid may be taken to be $N_2O_3 + Cl_4 + 3H_2O = 2HNO_3 + 4HCl$. 142 grs. of chlorine oxidising 76 grs. of nitrous acid into nitric acid.

By the equation—

$$\frac{7 \times 76}{142} = 3{\cdot}74$$

we have the quantity of nitrous acid corresponding to the 20 grains of the 35 per cent bleaching-powder, or the 7 grs. of chlorine.

But the pouret contains 363 grs. of *water*; therefore to get the real *weight* we must, of course, take into consideration the specific gravity of the vitriol. Now, in the test experiments, with every precaution taken to ensure accuracy, the following results were obtained, the permanganate being added until the pink colour remained after standing two minutes:—

Chloride of lime method.	C.c. of permanganate used to 10 c.c. of nitrous vitriol.
85	60
85	60
87	57
85	58
86	55
Average, 85·6	58

Now, taking the numbers and expressing the results on the volume, which is the method used I believe in many manufactories, as it dispenses with weighing, we have 3·74 grains of nitrous acid in 85·6 measures of the vitriol, each measure corresponding to 3·63 grs. of water.

The following equation will then give us the percentage of nitrous acid if we leave the specific gravity of the solution out of the question:—

$$\frac{3{\cdot}74 \times 100}{3{\cdot}63 \times 85{\cdot}6} = 1{\cdot}203.$$

Turning now to the average of the permanganate numbers, let us see how it agrees with the chloride of lime average:—

Each c.c. used = 0·0019 grm. of N_2O_3:

$0{\cdot}0019 \times 58 \times 10 = 1{\cdot}102$ per cent N_2O_3,

and the specific gravity being 1·74 the true percentage on the weight is—

Chloride of lime process, 0·75 } of N_2O_3.
Permanganate process, 0·63 }

Although I have said before that the organic matter of the vitriol might be acted upon by the permanganate more readily than the chlorine, yet, in this case, the permanganate gives lower results than the chloride of lime process, and that has led me to suppose that, on adding the nitrous vitriol in small quantity to the large quantity of water (containing, of course, dissolved oxygen), that oxidation takes place to a considerable extent. There is no gas left in the atmosphere of the flask after slight agitation, as with my experiments iodide of potassium and starch paper was not coloured in the slightest degree.

The five trials may then be tabulated thus :—

Chloride of lime, divisions of pouret.	Permanganate c.c.	Volumetric percentage by chloride process.	Volumetric percentage by permanganate.
85	60	1·212	1·140
85	60	1·212	1·140
87	57	1·184	1·083
85	58	1·212	1·102
86	55	1·198	1·045

It will thus be seen that the numbers and necessarily the percentage obtained by the chloride of lime process are very regular; but that method, even in my opinion, is very faulty, for directly the nitrous vitriol is poured into the chloride of lime, although it be greatly diluted, there is a large disengagement of chlorine, which of course is lost. I do not mean to say that such a large quantity is really lost, but that chlorine is escaping is soon rendered evident to the nasal organs, and even a small escape must affect the results.

In using the chloride of lime process it might be supposed that the standard solution of chloride of lime is quickly decomposed; this is not, however, the case if the solution is not directly exposed to the light and kept in a well-stoppered bottle. The first Winchester quart I prepared contained 7 grains of chlorine in 10 c.c.; after one month it was still 7 grs., and after two months, when the bottle was nearly empty, 10 c.c. contained 6·89 grs.

The sources of error in the permanganate process could, I believe, be reduced to a minimum if the nitrous vitriol was added to the permanganate solution. I have these experiments going on now, and I hope soon to lay the results before your readers.

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NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

V.

FATS are compound ethers of the triatomic alcohol glycerine—

$$\left.\begin{matrix}(C_3H_5)'''\\H_3\end{matrix}\right\}O_3.$$

Bases combine with the fatty acids contained in fats and oils, setting free glycerine and forming soap. Steam forced into fats at high pressure decomposes them, forming glycerine and fatty acids; the former being soluble in water is readily separated.

The rancidity of fats is due to an albuminous ferment setting free certain fatty acids present only in small proportions, such as butyric acid; this rancidity may be removed by washing with water, as the acids producing it are all soluble in that fluid.

Some oils absorb O and form varnishes; this property is called drying: cod-liver oil is the only animal oil acting thus. Oils, and, in fact, most fluids insoluble in water, form when dropped on that liquid figures called by Tomlinson (and described by him fully in his "Cyclopædia of Arts") cohesion figures; each distinct oil has a separate cohesion form, and by a practised eye an admixture of inferior oil may readily be seen when this experiment is performed; the vessel of water should be 6 inches in diameter and a small-bore pipette used to drop the oil from.

The proximate constituents of fats are olein, stearin, palmitin, and margarin. Olein is the fluid portion of oils, and does not solidify at 0° C. Stearin ($C_{57}H_{110}O_6$), a solid fat contained in mutton suet, soluble in boiling alcohol; separates on cooling. Palmitin ($C_{51}H_{98}O_8$) is another solid fat contained in bees'-wax, and is obtained by crystallisation from an etherial solution. Margarin, according to Heintz, is a compound of palmitic and stearic acids.

Natural Animal Fats and Oils.

Sperm oil and whale oil are unimportant.

Cod-liver oil has an importance due to its ready assimilation by the emaciated system of the phthisical patient. This property is due most probably to the bile contained in the oil. It consists chiefly of olein, some acetin, phosphorised fat, I, and Br; the two latter elements may be detected by saponification with KHO, evaporation, incineration, dissolving the ash in water, and testing with suitable reagents. H_2SO_4 acts on the bile resins, giving a crimson colour to the oil.

Butter consists of olein and palmitin, with butyrin, caproin, and caprylin; on saponification the corresponding acids are set free, known by their characteristic pungent odour.

Lard contains mostly olein. Suet contains stearin.

Spermaceti, a solid crystalline fat obtained from the sperm whale, does not yield glycerine when saponified, but ethal ($C_{16}H_{34}O$).

Bees'-wax consists of cerolein, soluble in cold alcohol, and to which the tenacity and odour of wax is due; cerotic acid, soluble in hot alcohol; and myricin, insoluble in alcohol. This latter is a mixture of a complex nature; the colour of wax is due to this.

Cholesterin ($C_{26}H_{44}O,H_2O$). This fat does not saponify; it is contained in bile, the liver, brain, and gall-stones; it crystallises from a solution in alcohol in rhomb.c plates.

The melting-point of a fat may be ascertained by introducing a capillary tube charged with the fat under consideration into melting paraffin in which a thermometer is placed; as soon as the fat in the tube melts, observe the temperature denoted by the thermometer, and the result is obtained. To charge a capillary tube with fat, melt the material and plunge in the end of the tube; when the melting fat is drawn up remove it, and as soon as it is cold the determinations may be made.

Fatty matters are soluble in ether and benzol.

ON THE

METHOD OF ASSAYING SILVER ADOPTED IN THE ASSAY OFFICES OF H.M. INDIAN MINTS.*

By H. E. BUSTEED, M.D.,
H.M. Madras Army, Officiating Assay Master, Calcutta Mint.

(Concluded from p. 246).

WITH regard to the weight of the small portion taken to represent the mass, the system prevails in the Indian mints of taking samples for assay by granulating a small portion of the contents of each melting-pot; when the metal is in a thorough state of fusion and has just been well stirred, a small ladleful of the molten metal is quickly poured from a tolerable height into a vessel of water, and the granules so formed received on a strainer, lifted out

* From the *Journal of the Asiatic Society of Bengal.*

and perfectly dried.* The weight of this specimen representing each pot was at first fixed at 24 grs., technically called the "assay pound;" this in the case of pure silver yielded 31·87 grs. of chloride of silver, while the same quantity of Indian standard silver (which is $\frac{1}{12}$ths silver plus $\frac{1}{12}$th copper = 916·66 in 1000) yielded one-twelfth less, or 29·21 grs.; on the weight of chloride being ascertained in each case a table which was calculated and prepared for the purpose was referred to and the equivalent fineness assigned to the $\frac{1}{4}$ dwt., plus the odd grs., when any. But when it became desirable to prepare for the decimal form of notation, a number more convenient than 31·87 was looked for to represent purity or 1000, and 25 was fixed on as a desirable starting-point, particularly as the quantity of pure silver yielding that amount of chloride, viz., 18·825 grs., was quite large enough to represent each pot.†

The weight, therefore, of the "assay pound" in use at present is 18·825 grs. This produces (with chlorine) in the case of pure silver 25 grs. of chloride of silver.‡

But to obviate the necessity of constant reference to a calculated table to find the equivalent in pure silver of the amount of chloride of silver found in each case, it was ingeniously arranged to stamp each of the assay weights not with its actual weight, but with the figures representing the proportion per mille of pure metal which such a weight of chloride so found corresponds to; thus, supposing a melting of five-franc pieces was being assayed, and the chloride resulting from the assay pound operated on, weighed 22·5 grs. (showing the actual pure contents in the sample to be 16·94 grs.), instead of referring to a table to see the equivalent per mille-age of pure silver, that weight which is actually 22·5 grs. has 900 marked on it, and the assayer simply reads the touch from it.

Accordingly the assay weights are as follows:—

Actual weight in Grs.		Figures marked on the weights.
25·000		1000·00
22·910	(Std.)	916·66
22·500		900·00
20·000		800·00
17·500		700·00
15·000		600·00
12·500		500·00
10·000		400·00
7·500		300·00
5·000		200·00
2·500		100·00
1·250		50·00
1·000		40·00
0·750		30·00
0·500		20·00
0·250		10·00
0·125		5·00
0·100		4·00
0·075		3·00
0·050		2·00
0·025		1·00

Assay lb., weight = 18·825 grs.

The assays for the valuation of merchants' bullion are reported to the $\frac{1}{1000}$th part, *i.e.*, the value of our smallest weight, and as the distance from zero to the point (shown by a scale and indicator) at which the balance "breaks" with this weight in either pan is sub-divided into five, the decimals over or under one-thousandth can be read off.

Accordingly assays are reported to the mint office (as a matter of interior economy, for facilitating the alligation arrangements) to 0·4 and 0·6 (*e.g.* "997·4": "900·6"), and the assays of the standard meltings and of the local pyx coins are reported to 0·2. Thus, reports are made with confidence by this process to a little over 1 gr. (1·152) in the troy pound.

Though the whole process can be carried through to completion in the case of a small number of assays within twenty-four hours, still in the ordinary heavy current work of the office, assays are not completed till the third day. Thus, the samples are tendered suppose on Monday; they are "weighed in," dissolved, and precipitated on that day; on the next they are washed and syphoned twice; and on Wednesday they are "potted," dried, and reported. The certificates of value (payable on demand at the Government Bank) are examined and signed by the assay master on the following morning and handed to the merchant or his agent. In like manner samples tendered on Tuesday are, under ordinary circumstances, weighed and reported by the assay master on Thursday, and so the work goes on steadily, under a systematised routine, where each hour has its assigned duty.*

An ordinary day-work consists of eighty assays,† estimating imported bullion to the value of four lacs of rupees, and standard meltings and coins to the value of five lacs. But on emergencies, in time of heavy pressure, by working extra hours, as many as 164 assays have been daily conducted, estimating bullion to the value of eight lacs of rupees, and standard coins and meltings to the value of fourteen lacs.

Such is an outline of the method of assay worked on a large scale; of course successful results from it cannot be expected unless each step in the manipulation be conducted with great care and accuracy, and only then after much practice and experience.

The natives of this country possess great aptitude in acquiring the skill and confident lightness of touch so essential for delicate manipulation; this, added to their characteristic patience, makes them admirable subordinates in an assay laboratory, under judicious supervision;* moreover, their labour is cheap; so that, on the whole, the process seems to be especially suitable for an Indian mint.

When bar silver is imported from the Continent, the assays of it, made here, almost invariably correspond most closely with those previously made of it in Paris by the volumetric method. But were further proof needed of the practical accuracy of our system, it is to be found in the very close proximity to the legal standard, at which the large Indian coinage has been maintained for many years, as annually reported by the assayers to the Royal Mint of Great Britain, who test the fineness of the Indian pyx coins by the French humid process.

* The introduction into the Calcutta Mint of this system of taking musters is, I find, attributable to Dr. Boycott, late Assay Master, and to Dr. Shekelton, who, by a number of interesting experiments, satisfied themselves that samples so taken represent the mass of mixed metal to be valued much more fairly than samples of the same mass cut or gouged from it after it has been poured and allowed to cool in the ingot moulds where a partial separation of the copper from the silver seems to take place; the result being, according to the above experiments, that in the case of ingots cast in upright moulds, all the outside is much below the average fineness of the mass on assay, and the centre much above it. This refers to alloys of silver and copper mixed in or about the proportion of "standard." According to Monsieur Levol, however, it would appear that when an alloy of silver and copper in which the proportion of the latter is very high (viz., over 28 per cent) has been melted, poured, and allowed to cool, an opposite result to the above is found, viz., the outside of the ingots is above the average fineness. An assay therefrom from a granulated sample must give a much nearer approximation to truth than one from a cut sample.

† The average weight of the contents of each melting-pot is 12,500 tolas, or about 390 pounds Troy, so that the specimen taken to represent this is but about the 119,000th part; each sample is assayed in duplicate.

‡ The basis for these numbers was founded on the proportion in which, according to Turner, silver combines with chlorine, viz., 100 parts with 32·80.

* When holidays or Sundays intervene, the current work is so arranged that the chlorides are not allowed to remain an undue time exposed in the bottles, more especially after the second syphoning, when a minimum of acid is present; under such circumstances, the chlorides are found to lose somewhat in weight, becoming finely divided, easily broken, and showing a tendency to adhere to the cups; similar results from allowing the chlorides to remain in the bottles with insufficiency of acid have been found to follow even when the bottles have been the whole time secluded from light. Syphoning too low must also, for similar reasons, be guarded against.

† Exclusive of any gold assays which may be going on.

* The Calcutta Assay Office has been been fortunate in the possession of its Foreman, Mr. Frewin, who, for over 30 years has been actively engaged in assay operations. He was head assistant in the office under Mr. Dodd when the latter was investigating the adaptation of this system, and no doubt Mr. Frewin's intelligence and dexterity contributed to its successful introduction and subsequent working; he has trained numerous subordinates to the laboratory work who have turned out expert manipulators.

Without this method (improved and made more perfect, as it has been, in the hands of successive assay officers), it would, to my mind, have been very difficult for the assay establishments of the Indian mints to have dealt with, in the same time and with the same accuracy, the immense importation of silver to India during the last fifteen years. In the single year 1865-66, there was poured into the Indian mints, and manufactured into coin, silver alone reaching in value to the prodigious amount of over fourteen millions sterling.

The system which enabled the assay officers to value such a rapid and heavy influx with accuracy, and with satisfaction to the importer on the one hand and to the mint (the buyer) on the other, and to faithfully maintain the immense resulting coinage close to legal standard, has been put to a severe test. If success be the criterion of merit, the 20 years' large experience of this method gained in the Indian mints goes, I think, to show that it is worthy of a yet wider field of utility.

Appendix.

(1.) The bottles used in this process are of thin (but strong) white glass and contain about 12 fluid ozs.; about six inches in height and 2¼ inches in diameter at the bottom, which should present a perfectly even, level floor; they are without any (abrupt) shoulder, but become gradually pyramidal from about half way up to the neck; this shape favours the easy dropping out of the chloride. The neck is about one inch in length, polished on its inner surface; the stoppers are of ground glass, polished, with globular heads, and are made to fit with the utmost accuracy and smoothness. The bottles and stoppers are numbered, to correspond with the number on the muster board and also on the cups.

(2.) The "cups" are Wedgwood crucibles, smooth and thin, about 1¼ inches in height, 1¼ inches in diameter above, and a little less than 1 inch in outside diameter at the bottom. The floor should be perfectly level, and neither it nor the sides should present any roughness likely to retain the chloride. The cups are all numbered.

(3.) The porcelain saucers are shallow, ¾ of an inch in depth; the upper diameter is about 4 inches, the lower 2½ inches.

(4.) The turn-table is a circular board of about 3 feet in diameter, fenced by a brass railing (or by a simple ledge); its centre is occupied by a raised platform about 2 feet in diameter, between which and the rail the bottles (26 on each) stand, the round outer edge of the platform having semi-lunar niches cut in it, into which the bottles fit; opposite to each niche on the platform is a little concavity in which the stoppers rest when not in the bottles. Each turn-table is made to revolve on its centre in either direction, and is raised about 6 inches above the long general table on which all are supported; close to each a funnel is fitted into the lower (supporting) table for conducting away the fluid syphoned from each set of bottles.

(5.) The trough is a basin of cast-iron (painted); it may be oblong or round, raised to about the height of 3 feet from the ground; when round and large enough for twenty bottles, space and distilled water may be economised by having a platform insulated in the centre. This is convenient for resting the bottles on after the chlorides have been got out. A trough of this kind may be about 2½ feet in diameter, having a space 7 inches broad and 4 deep all round between the circumference of the basin itself and the outer edge of the island platform. Into this space is poured distilled water to the depth of 3 inches. From the rim of the trough hang as many brass supports as there are bottles to be inverted; these are two circular clasps connected at the back to a bar common to both; one, the larger, is 1½ inches above the smaller and lower one, which is under water; they are open in front (or towards the centre of the basin) to about ¾ of an inch in width. The openings of both are in the same line, owing to the lower (smaller) segment being projected towards the centre by an abrupt curve in the connecting bar, by which they hang from the brim. This arrangement receives and fixes the inverted bottles in the required position. The distilled water is removed from the trough by the withdrawal of a plug. These troughs are sometimes made to revolve on the centre.

(6.) The drop bottle used for washing down the glass rod when breaking up the chlorides, and for sprinkling the surface of the cups, in small sized, round, so as to be easily grasped; it holds about 6 ozs. The stopper is hollow, with two small tubes leading from its head, one opposite to the other. Glass is so liable to break or chip that a hollow silver stopper is now generally substituted.

(7.) The steam-bath is simply a square vessel made of sheet copper, between 3 and 4 inches deep, the top or upper plate of which has a number of circular openings about two-thirds of the diameter of a Wedgwood crucible. There is also a steam escape pipe leading from the centre below to about a foot in height. They are of various sizes to contain from 10 to 150 pots: they are raised or moved by two lateral handles.

(8.) Hot air plate of thin sheet iron bored with holes for the reception of the crucibles, raised by iron feet about 1½ inches above the furnace plate. It is furnished with a square tin cover which fits over it. This is provided with lateral apertures for the escape of heated air, and with a tube from its roof for the reception of a thermometer.

The drying furnace on which the above rest is surmounted by a hood, the door of which (glazed) slides up and down by weights and pulleys; the plate is heated by means of gas jets; it has a good draught to carry off the nitrous fumes, as on it the musters are dissolved in the first instance on a sand bath.

(9.) The forceps for removing the cake of chloride from each cup to the skiff of the balance should not be too sharp in its grasp; it is much improved by having the blades tipped for about an inch from the points with platinum about ⅛ inch in width.

(10.) It is a convenience to have the assay weights arranged in a set of ivory compartments in the weight box; on the floor of each compartment are engraved the figures corresponding to those engraved on the weight which occupies it; by this means the assayer has merely to glance at his weight box to see what weights are in the pan of the balance, and to read off the "touch" when each chloride is counterpoised.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

November 16th, 1871.

Mr. Riley, whose remarks were not fully reported in our notice of the proceedings of the Chemical Society last week, has forwarded the following statement for publication:—

Mr. Riley was sorry he only heard the latter part of the paper just read, and said that the mechanical treatment of iron should be considered quite as much as the chemical composition of the iron. Thus iron that was quite brittle, such as puddler's old rabbles, when piled, heated, and rolled two or three times, became fibrous to a certain extent, and much improved in quality. The best fibrous wrought-iron, after being melted, became very red-short.

Much misconception existed as to the injurious action of the so-called impurities in iron.

He found that excellent tool steel that worked well under the hammer and stood the severest tests (burning off

the skin of cast-steel wheels) contained an amount of silicon that would be very prejudicial in white cast-iron, and make it difficult to puddle.

In reply to Dr. Odling's queries as to sulphur and phosphorus, he considered sulphur mostly injurious, although it made No. 1 pig stronger (the most highly graphitic iron) by reducing it to Nos. 3 or 4, less graphitic pig, which was a stronger iron.

No one would, however, think of using sulphur, as the highly graphitic iron being the most difficult and expensive to produce, there was always sufficient of a lower quality (white or mottled) to mix with No. 1 pig so as to reduce it to Nos. 3 or 4.

He considered that in pig-iron, a certain amount of phosphorus was advantageous, as without it the iron, when puddled, worked red-short; thus the best Swedish pig made a red-short iron, and its quality would be improved by mixing a lower quality containing phosphorus with it, such as Cleveland or Derbyshire pig.

Low Moor and Bowling pig contains uniformly about 0·64 per cent of phosphorus, the amount being the same generally when the best clay iron-stones are used in South Wales either with hot or cold blast; there was no doubt that such pig made the best wrought-iron, and commanded a higher price than Swedish charcoal pig.

Phosphorus in steel is certainly injurious, and anything much over 0·10 per cent he considered very detrimental. The sample referred to contained 2·07 per cent of silicon.

In puddling iron he considered it was essential to have some silicon in the pig; good white forge pig usually contains from ¼ to 1 per cent, whereas inferior white pig frequently contains only 2-10ths to 3-10ths per cent.

Tungsten is being used by Mr. Mushet in his so-called "special" steel; it contains more than 10 per cent, and is an excellent steel for certain kinds of cutting tools; it requires no hardening.

CORRESPONDENCE.

HEAT AND ELECTRICITY.

To the Editor of the Chemical News.

Sir,—It is doubtless true that the heating power of a current is proportional to the square of its strength; but, unless I misunderstand Mr. Highton, he did not measure the strengths of the *currents employed to heat his wires* at all. He measured the currents given by the cells acting against the small resistance of his tangent galvanometer, but surely he does not suppose that the ratio between the currents will remain the same when the resistance of the circuit is altered by introducing a thin wire. That it should do so it would be necessary that the electro-motive forces of the cells should be alike. A single Grove cell will give the same deflection of a tangent galvanometer needle as ten or fifty similar cells, but the heating power will be very different.

Let Mr. Highton repeat his experiments introducing the galvanometer into the *same circuit* with the red-hot wire; he will then, I think, get a result more in accordance with the rule.—I am, &c.,

W. J. Wilson.

Birkbeck Institution, Nov. 27, 1871.

DUMAS'S VAPOUR DENSITY DETERMINATIONS.

To the Editor of the Chemical News.

Sir,—I shall be glad if you will grant me a little space in your journal to notice two errors with reference to Dumas's "Vapour Density Determinations," to be found in most of the text-books which treat of the subject, which I mentioned in the *Journal of the Chemical Society* last year, but to which Dr. W. M. Watts has again called attention in your issue of November 10th.

The first error alluded to is that no directions are given to observe the atmospheric temperature and pressure at the second weighing. This error has, no doubt, crept in and remained unnoticed owing to the fact that, as a rule, the height of the barometer and the temperature of the balance room would not vary perceptibly in the short time required for a determination, and that they would therefore be practically the same at both weighings.

Dumas's bulbs displace 10 to 20 c.c. of air, which weigh under ordinary circumstances 12 to 24 milligrammes (not by any means an *extremely small* quantity), but this quantity may be disregarded except in extreme cases, seeing that a variation of 5° C. in the temperature or 12 m.m. in the pressure will only affect the apparent weight of the bulb to the extent of 0·2 to 0·4 milligrammes. If, however, it is necessary to make allowance for variation of temperature or pressure the following correction must be applied to the formula:—

Let P = apparent weight of globe at t° C. and H m.m.
P′ = apparent weight of globe and vapour at t'° and H′.
D = density of material of which the globe is composed (water = 1).
$(a\mathrm{H})$ = weight of c.c. of air at t° and H.
$(a'\mathrm{H}')$ = weight of c.c. of air at t'° and H′.
V = capacity of globe in c.c.
v = volume of residual air.

Then the absolute weight of globe $= \mathrm{P}+\frac{\mathrm{P}}{\mathrm{D}}(a\mathrm{H})$.

And the absolute weight of globe and vapour =

$$\mathrm{P}'+(\mathrm{V}-v)(a'\mathrm{H}')+\frac{\mathrm{P}}{\mathrm{D}}(a'\mathrm{H}').$$

And the absolute weight of vapour =

$$(\mathrm{P}'-\mathrm{P})+(\mathrm{V}-v)(a'\mathrm{H}')+\frac{\mathrm{P}}{\mathrm{D}}((a'\mathrm{H}')-(a\mathrm{H})).$$

Which only differs from the numerator of the Dumas formula by the quantity $\frac{\mathrm{P}}{\mathrm{D}}((a'\mathrm{H}')-(a\mathrm{H}))$.

The second error alluded to is that an incorrect expression is given for the actual weight of the bulb. This error is liable to mislead the student, although it will not affect the result, as it does not occur in the formula for the density but only in the verbose explanations. Those, therefore, who use the formula without troubling themselves about its construction will not introduce the error into their work.

If absolute accuracy were required in weighing, and if the balances generally used would weigh to 0·05 milligramme, it would, of course, be necessary to take into account the effect of the atmospheric variations on the apparent value of the weights themselves.—I am, &c.,

James J. Brown.

Sudbury, Harrow,
Nov. 21, 1871.

MISCELLANEOUS.

The Royal Society.—The annual meeting of the Fellows of this society was held yesterday at Burlington House, when Lieut.-General Sir Edward Sabine, R.A., K.C.B., resigned the high office of President, which he has so worthily filled since 1861, and the Astronomer Royal, who, by his untiring zeal and energy, has contributed largely to the advancement of science, was elected to fill the Presidential Chair. The Copley Medal was awarded to Dr. Julius Robert Mayer, and the two Royal Medals were presented to Drs. Stenhouse and Busk. The following gentlemen were appointed officers and council for the ensuing year:—*President*—George Biddell Airy, M.A., D.C.L., LL.D., Astronomer Royal. *Treasurer*—William Spottiswoode, M.A. *Secretaries*—William Sharpey, M.D., LL.D.; Professor George Gabriel Stokes, M.A., D.C.L.,

LL.D. *Foreign Secretary*—Professor William Hallowes Miller, M.A., LL.D. *Other Members of the Council*—George James Allman, M.D.; John Ball, M.A.; George Burrows, M.D.; Mr. George Busk, P.R.C.S.; Professor Robert Bellamy Clifton, M.A.; Heinrich Debus, Ph.D.; Professor Peter Martin Duncan, M.B.; Professor George Carey Foster, B.A.; Mr. Francis Galton; Thomas Archer Hirst, Ph.D.; Sir John Lubbock, Bart; Sir James Paget, Bart., D.C.L.; The Earl of Rosse, D.C.L.; General Sir E. Sabine, R.A., K.C.B.; Isaac Todhunter, M.A.; Sir Charles Wheatstone, D.C.L.

Royal Institution of Great Britain.—The following are the Lecture arrangements for 1871-72:—The Christmas Lectures, adapted to a juvenile auditory, will be delivered by Prof. Tyndall, LL.D., F.R.S., "On Ice, Water, Vapour, and Air," on December 28, 30, 1871; January 2, 4, 6, 9, 1872, at three o'clock. The other lectures before Easter, 1872, are:—Ten lectures "On the Nervous and Circulatory Systems," by Dr. W. Rutherford, F.R.S.E., on Tuesdays, January 16 to March 19. Ten lectures "On the Chemistry of Alkalies and Alkali Manufacture," by Professor Odling, F.R.S., on Thursdays, January 18 to March 21. Six lectures "On Literature," by W. G. Donne, Esq., on Saturdays, January 20 to February 24. Four lectures "On Demonology," by Moncure D. Conway, Esq., on Saturdays, March 2 to 23. The Friday Evening Discourses before Easter will probably be given by Mr. W. R. Grove, Q.C., the Archbishop of Westminster, Professors Odling and Humphry, Dr. Gladstone, Messrs. C. W. Siemens, R. Liebreich, and John Evans, and Professor Tyndall; the first meeting will be on January 13, 1872. After Easter the lectures will comprise—Three lectures "On Statistics, Social Science, and Political Economy," by Dr. Wm. A. Guy, F.R.S., on Tuesdays, April 9, 16, and 23. Six lectures "On the Development of Belief and Custom amongst the Lower Races of Mankind," by Ed. B. Tylor, Esq., F.R.S., on Tuesdays, April 30 to June 4. Nine lectures, by Professor Tyndall, LL.D., F.R.S., on Thursdays, April 11 to June 6. Five lectures "On Star Depths," by R. A. Proctor, Esq., B.A., F.R.A.S., on Saturdays, April 13 to May 11. Four lectures "On the Chemical Action of Light," by Professor Roscoe, F.R.S., on Saturdays, May 18 to June 8.

The Royal Polytechnic.—On Monday evening last, Mr. T. W. Tobin, who was captain of Mr. Streeter's expedition to the diamond fields of South Africa, delivered an exhaustive lecture on this discovery. Mr. Tobin's practical knowledge of the subject, together with his series of original sketches and the specimens of diamonds, rubies, and garnets (which were magnified), made the lecture an instructive one, and from the applause which followed its delivery it was evident that the large audience was much interested. Professor Pepper presided, and during the lecture practically demonstrated that the diamond is identical in composition with ordinary charcoal. The lecture will, we believe, be repeated daily.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 15, 1871.

This number contains the following original papers and memoirs:—

Contribution to our Knowledge of the Cinchona Barks.—O. Hesse.—In the introduction to this paper, the author calls attention to the fact that Grahl's test for detecting the genuineness of cinchona barks does not rigorously apply, inasmuch as with any bark which contains more or less of the cinchona alkaloids—even though such bark be not, in botanical and pharmacognostical sense, a cinchona bark—the reaction discovered by Grahl is observed. The reaction alluded to is that when a piece of a cinchona bark, or one which contains cinchona alkaloids, is gently heated in a test-tube held in a horizontal position, so that it gives off tarry matter, that fluid is carmine-red coloured, a reaction which Batka states always takes place when cinchona alkaloids are heated along with pure cellulose. The greater portion of this paper is devoted to the description of the results of some experiments made with a new kind of cinchona bark, which has been named *China cuprea* on account of its fine red colour, bluish red in the state of powder. The ammoniacal solution of this bark has a purple-red colour; this solution tinges white filtering-paper rose-red. The tannic acid present in this bark appears to be different from that found in the genuine cinchona barks; the quantity of alkaloids found in this bark amounts to from 2·12 to 2·25 per cent, viz.:—Quinine (pure alkaloid), 1·26; conchinin, 0·46; cinchonin, 0·22; amorphous bases, 0·34; chinidin and paricin are not as yet found in the *China cuprea;* the amorphous bases are present as such in this bark, and are not the result of decomposition of other alkaloids by the action of reagents.

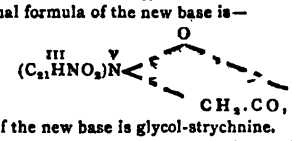
New Base from Strychnine.—A. Strecker.—3 parts of finely pulverised strychnine and 1 part of monochloracetic acid were first heated to 180° for a period of four to five hours. The cooled mass, having been dissolved in water, was saturated with ammonia, and the mixture filtered, the filtrate yielding, on evaporation, a crystalline mass, the new base, a body difficultly soluble in cold but more readily so in hot water, also in alcohol, but not at all in ether. On analysis, results were obtained leading to the formula $C_{23}H_{24}N_2O_4$, confirmed by the analysis of the platinum double salt of this substance, which yields with acids salts, some of which (the nitrate and oxalate) are very difficultly soluble in water. The formation of this base is illustrated by the following formula:—

$$C_{21}H_{22}N_2O_2 + C_2H_3ClO_2 = C_{23}H_{24}N_2O_4Cl.C_{23}H_{24}N_2O_4Cl + NH_3 = C_{23}H_{24}N_2O_4 + NH_4Cl.$$

This base is distinguished from brucine by 2H less, while the new base contains $C_2H_2O_2$ more, than strychnine. With bichromate of potassa and concentrated sulphuric acid, this new base yields the same reaction as strychnine. Taking the constitutional formula of strychnine as—

$$(C_{21}H_{22}NO_2)N,$$

the constitutional formula of the new base is—



and the name of the new base is glycol-strychnine.

On Hexyl-Alcohol from Heracleum Oil.—A. Franchimont and Th. Zincke.—After first referring at some length to some former experiments on this subject, the authors describe a series of experiments made with Heracleum oil, from which they obtained by fractional distillation and treating with alcoholic potassa solution, a hexyl-alcohol, $C_6H_{14}O$, a liquid not miscible with water; sp. gr. = 0·819; boils at 156·6°; by oxidation, it yields an acid containing the same quantity of carbon. The hexyl-iodide, the acetate, and the capronate of this body have been prepared by the authors, and described. The iodide, $C_6H_{13}I$, is a colourless liquid, insoluble in water, but miscible with alcohol and ether; sp. gr. = 1·4115; boils at 179·5°. The acetate, $C_6H_{13}.(C_2H_3O)$, is a very pleasant-smelling fluid; sp. gr. = 0·889; boils at 168·7°. The capronate, $C_6H_{13}(C_6H_{11}O)O$, is a fluid oil almost devoid of smell; sp. gr. = 0·865; boils at 245·6°. From carefully-made comparative researches, the authors infer that the hexyl-alcohol alluded to is a hitherto unknown body.

Researches on the Invisible Photographic Image.—H. Vogel.—We regret that it is not possible to give an abstract of this excellent paper, owing to the fact that it would require the reproduction of a large number of formulæ.

Decomposition of Nitric Acid by Heat.—L. Carius.—This lengthy and exhaustive essay, being illustrated by a woodcut and several tabulated forms exhibiting results of experiments, does not admit of any suitable abstraction, notwithstanding its intrinsic merits.

Some Nitrogenous Compounds of Milk-Sugar.—R. Sachsse.—After briefly referring to the experiments made by Dusart, Thenard, and Schützenberger, on the action of ammonia upon the carbohydrates, the author gives a preliminary account of some experiments made by him on the action of aniline upon carbohydrates, and, in the first place, upon milk-sugar: hereby are at least two different compounds formed; one of these was found, by elementary analysis, to give results leading to the formula $C_{20}H_{49}NO_{21}$, while the other's formula was ascertained to be $C_{36}H_{54}N_2O_{20}$. The formation of these bodies may be illustrated by the following formulæ:—

$$\text{(I).}\quad C_{24}H_{44}O_{22} + C_6H_7N = C_{20}H_{49}NO_{21} + H_2O.$$
$$\text{(II).}\quad C_{24}H_{44}O_{22} + 2C_6H_7N = C_{36}H_{54}N_2O_{20} + 2H_2O.$$

Contribution to our Knowledge on the Benzoin Series.—Th. Zincke.—An exhaustive and very lengthy memoir on the constitutional formulæ of this very extensive series. Notwithstanding the very great scientific value of this essay, its contents, elucidated by a large number of complex formulæ, are not suited for abstraction.

Application of the Second Main Point of the Mechanical Theory of Heat to Chemical Phenomena.—A. Horstmann.

Acetnaphthalid and some of its Derivatives.—P. Rother.—Acetnaphthalid ($C_{10}H_7.NH.C_2H_3O$), obtained by heating for several consecutive days naphthylamine and glacial acetic acid, is a solid crystalline body, insoluble in cold, readily soluble in hot, water and alcohol; fuses at 159°; treated with fuming nitric acid in the cold, it yields binitro-acetnaphthalid ($C_{10}H_5(NO_2)_2.NH.C_2H_3O$). This new compound is almost totally insoluble in water either cold or hot, soluble in alcohol, but insoluble in ether, benzol, chloroform, and glacial acetic acid. Acetnaphthalid combines with bromine, forming a monobromide ($C_{10}H_6Br.NH.C_2H_3O$), insoluble in water, but soluble in boiling alcohol; from the alcoholic solution this body crystallises readily. By the action of caustic potassa solution upon this last compound, there is formed monobrom-naphthylamin ($C_{10}H_6Br.NH_2$), fusing at 94°, and combining with acids to form salts.

Preliminary Notice on the Reaction between Oxychloride of Phosphorus and Phosphoric Anhydride.—G. Gustavson.—When equivalent quantities of phosphoric anhydride and oxychloride of phosphorus are heated in a sealed tube at 200° for some thirty-six hours, there is formed a thickish transparent mass, probably the chloride of the metaphosphoric acid, formed according to the following formula:—$P_2O_5+POCl_3=3PO_2Cl$. The author is still engaged in these experiments.

La Revue des Scientifique de la France et de l'Etranger, November 11, 1871.

This number does not contain any original papers on chemistry, but we call attention to the following excellent memoirs:—

Freedom of Superior Instruction.—M. Lorain.—A well written and digested essay on the higher branches of education, and the duties of the state in respect thereof.

Poisoning with Carbonic Oxide Gas.—M. Gréhaut.—This memoir, illustrated by engravings, is an excellent specimen of experimental physiology, as taught by the author at the Practical Lectures of the Medical Faculty of Paris.

November 18, 1871.

In addition to an essay to be presently more fully alluded to, this number contains the following original papers which, although not strictly relating to chemistry, deserve attention:—

Middle Class Education in France.—M. Lorain.

The Regulators (Régulateurs) of Human Life in a Physiological Sense.—Dr. J. Moleschott.—This is the author's opening lecture of his course of physiology at the University of Turin; for clearness, distinctness, and eloquent mode of treating the subject (a general review of the principal functions of the human body), this lecture deserves the attention of all interested in this matter.

Excretion of Urea by the Kidneys.—Dr. Gréhaut.—A great portion of this lecture is devoted to anatomy and physiology, but, speaking of the quantitative estimation of urea, the author states that he has improved Millon's process for this purpose, the advantages of the author's mode of operating being that—(1). It is not necessary that the urea be pure; it may be even contaminated with albuminoid matters, salts, and fatty matters. (2). No weighing is required, since the gases (nitrogen and carbonic oxide) resulting from the decomposition of the urea are completely collected in graduated tubes. (3). The process is very correct, because the author's apparatus (unfortunately this cannot be well understood without reproduction of woodcuts) enables the operation to be performed in a vacuum, and even 1 centigrm. of urea may be successfully operated upon. This excellent and very complete paper also treats on the estimation and detection of urea in blood, while, moreover, an ingenious apparatus for accelerating evaporation of liquids at a high temperature is described and illustrated by an engraving.

November 25, 1871.

This number does not contain any original papers relating to chemistry, but we must not omit to quote the title of the following essay:—

Electric Properties of the Nerves and Muscles During the State of Embryonic Life and During the State of Putrefaction.—Dr. Valentin.—An experimental physiological essay.

Polytechnisches Journal von Dingler, second number for October, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied subjects:—

Studies on Blast-Furnaces and Pig-Iron Production.—C. Schinz.—Continuation of this exhaustive memoir. This portion consists of a series of tabulated forms exhibiting the results obtained by the actual working of blast-furnaces.

Volumetrical Estimation of Iron and Ferrocyanogen.—H. Rheineck.—This paper treats on the quantitative estimation of iron and Berlin blue in liquids used in dye-works, but the contents are not suited for any useful abstraction.

Method for Testing Bleaching-Powder (Hypochlorite of Lime).—Dr. Graeger.—The author prepares a very dilute and strongly acidified solution of protosulphate of iron, which is exactly titrated with 1-10th solution of permanganate of potassa. Into this solution, kept in a bottle, the solution of bleaching powder is poured by the aid of a pipette, and, the bottle having been stoppered, the mixture is shaken up, and afterwards the undecomposed iron salt estimated by the aid of permanganate; 100 c.c. of that solution correspond to 3·546 grms. chlorine and to 0·8 grm. oxygen. To 1 grm. of bleaching-powder, considered as containing 3·3546 grms. chlorine, is required 0·278 grm. sulphate of iron, but it is best to take 0·4 to 0·5 grms. of that salt. The ammonio-sulphate of iron cannot be used on account of the danger consequent upon the formation of chloride of nitrogen.

Extraction of Sugar from Molasses by the Aid of Baryta.—Dr. G. Lunge.—An excellent practical treatise on this subject. Saccharate of baryta is formed, and this salt decomposed by carbonic acid, and the carbonate of baryta again converted into caustic baryta.

Preservation of Timber Used in Mines, Coal-Pits, and Quarries.—Dr. Dingler.—This lengthy essay contains the results of a series of practical experiments made with various kinds of wood and almost all substances which have been used to impregnate wood for the purposes of preserving it. It appears that wood thoroughly impregnated with a strong brine (solution of common salt) keeps very well underground.

Relative Goodness and Durability of Timber Felled in Winter or in Summer.—M. Burckhardt.—This subject has never been very much investigated, and the author states, therefore, that very possibly this question cannot be answered. He is inclined to the belief that if trees felled in summer are shelled (the bark stripped off), immediately after having been cut down, the timber thus obtained is in no ways inferior to that obtained from trees cut down in winter.

Journal für Praktische Chemie, No. 17, 1871.

The following original papers are published in this number:—

On Uramidobenzoic Acid Ethyl-Ether and Carboxamidobenzoic Acid Ethyl-Ether.—P. Griess.—After referring to some researches made about three years ago on uramidobenzoic acid, urea, and carboxamidobenzoic acid, the author describes the following bodies:—Ether of uramidobenzoic acid, $C_8H_7N_2O_3,C_2H_5$, a solid body, difficultly soluble in water, fuses at 176°; carboxamidobenzoic acid ether—

$$C_{18}H_{10}N_2O_6(C_2H_5)_2\left\{\begin{matrix}C_7H_4,N\left\{\begin{matrix}HO_2,C_2H_5\\CO\end{matrix}\right.\\C_7H_4,N\left\{\begin{matrix}CO\\HO_2,C_2H_5\end{matrix}\right.\end{matrix}\right.$$

a solid crystalline body, insoluble in water, readily soluble in warm alcohol and ether, fuses at 162°, decomposed by boiling alcoholic caustic potassa solution into alcohol and carboxamidobenzoic acid.

Origin and Properties of Monochlorcitramalic Acid.—Dr. J. Gottlieb.—This exhaustive and very lengthy memoir contains the following sections:—Preparation of monochlorcitramalic acid; hydrate of monochlorcitramalic acid, silver, baryta, and lead salts of this acid, $C_5H_7ClO_5$.

Rational Composition of Chlorcitramalic Acid.—H. Kolbe.—Notwithstanding the high scientific value of this paper, its contents are not suited for useful abstraction, on account of the fact that the value of this paper rests entirely upon a series of very lengthy and complicated formulæ. The author incidentally observes that citraconic acid should not be treated with liquid hyponitric acid; the author while doing this, in the expectation of thus obtaining dinitropyrotartaric acid, witnessed the most violent explosion which, to his knowledge, could occur in a chemical laboratory; although the quantity of material was only small, the effects were of a most serious nature, though fortunately nobody was hurt.

On some of the Nitrogen Compounds of Anthrachinon.—R. Bœttger and T. Petersen.—The first instalment of a lengthy essay on this subject, divided into the following sections:—α dinitro-anthrachinon, $C_{14}H_6(NO_2)2O_2$; α diamido-anthrachinon,

$$C_{14}H_6(NH_2)_2O_2;$$

behaviour of α diamido-anthrachinon with nitric acid; behaviour of α dinitro-anthrachinon with concentrated sulphuric acid.

Les Mondes, November 23, 1871.

Experiments in the Mont Cenis Tunnel.—Rev. A. Secchi, S.J., accompanied by Dr. Diamilla-Muller and the Rev. Denza, S.J.—The eminent *savants* just named have paid a visit to the tunnel alluded to with the view of inspecting that work, wherein already exists a large room hewn laterally out of the rock, to ascertain how far it will be possible to make a series of experiments (pendulum for gravity, magnetic, on the temperature of the rock, &c.) in the tunnel, as well as on the mountains through which it is bored. The experimenting party have already ascertained that the passage of railway trains through the tunnel does not perceptibly affect the accuracy of the experiments intended to be made, and of which a full and complete programme will be drawn up during this winter and all necessary arrangements made for execution next summer. The railway companies have promised every assistance in this work, the preliminaries of which will be made at Rome during this winter.

New Process of Panification.—Dr. Sézille.—The wheat is first deprived of its epispermum (outer cover, or husk) by means of properly constructed machinery; the decorticated grain is next several times acted upon by tepid water (about 80° for the first bath and 40° for the subsequent ones), whereby the gummo-resinous cover of the grain is dissolved and removed. This removal is necessary on account of the fact that this substance becomes very deep brown, almost blackish, coloured by fermentation of the dough; the grain at the same time absorbs from 65 to 70 per cent of water, and is then reduced to a paste by means of machinery very similar to that used in chocolate mills. This perfectly white paste is next leavened, and after fermentation ready for baking. By this process, from the same quantity of grain

which by the usual process only yields 108 to 110 kilos. of bread, the yield is increased to 145 kilos. of very superior quality and far greater nutritive power; moreover, a very considerable saving of labour and expenses connected therewith is effected by the application of this new process, which has been thoroughly tested by competent and independent scientific as well as practical men.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, November 16, 1871.

Toepler's Electrical Machine.—Dr. Albertier.—The detailed description, accompanied by woodcuts, of a peculiar and greatly improved electrical machine (friction) whereby the machine charges itself with negative electricity.

Continuation of the Chemical Researches on Nutritive Substances.—C. Mène.—This portion of the essay treats on the action of the saliva in the digestion.

Bibliography.—Under this heading we meet here with a brief review of "Eléments de Chimie Organique," par M. le Dr. Sacc, Professor of Chemistry at the University of Neufchâtel, published at Paris by Lacroix. This work, specially intended for students who commence to learn organic chemistry, is highly spoken of on account of the clear style and excellent classification of the subject.

Zeitschrift für Chemie von Beilstein, No. 11, 1871.

This number contains the following original papers:—

Chlorhydrates of Hydroxylamin.—W. Lossen.—In addition to the monochlorhydrate of hydroxylamin, NH_3O,HCl, there have been discovered by the author a semichlorhydrate, $2NH_3O,HCl$, and sesquichlorhydrate of the base just named, $3NH_3O,2HCl$. The former of these two bodies is prepared by adding to the monochlorhydrate of hydroxylamin in concentrated aqueous solution an equivalent quantity of hydroxylamin dissolved in absolute alcohol; while the sesquichlorhydrate is prepared by mixing the mono- and semi-chlorhydrate, and dissolving them in the smallest possible quantity of tepid water. The new salt crystallises from this solution. The two new salts are deliquescent, very soluble in water and weak alcohol, hardly so in absolute alcohol, and insoluble in ether. The semichlorhydrate fuses at 85°, the sesquichlorhydrate at 95°. The reactions exhibited by these substances correspond very closely to those of hydroxylamin.

On an Isomeric Chloro-Nitro-Phenol.—A. Faust.—The author describes briefly the following substances obtained by a complicated process from dinitro-chlorphenol, first converted into amido and then into diazo compounds:—Hydrochlorate β amido-nitro-chlorphenol, $C_6H_2ClNH_2NO_2O.HCl$, a yellow-coloured crystalline body soluble in water. Sulphate amido-nitro-chlorphenol—

$$(C_6H_2ClNH_2NO_2O)_2SO_4H_2,$$

also crystalline and readily soluble in water; the baryta salt of this compound, $(C_6H_2ClNH_2NO_2O)2Ba+4H_2O$, is a crystalline substance, and its aqueous solution exhibits a deep brown colour. β chlornitro-phenol, $C_6H_4ClNO_2O$, is crystalline, soluble in water, ether, alcohol, and chloroform, and fuses at 111°; its potassa salt, $C_6H_3NO_2ClO.K+H_2O$, is a brown-coloured crystalline salt soluble in water. Hydrochlorate of amido-chlorphenol, $C_6H_4ClNH_2O.HCl$, obtained from β chlornitro-phenol by reduction with tin and hydrochloric acid and removal of tin by sulphuretted hydrogen—

$$C_6H_4ClNH_2O.HCl,$$

a yellow-coloured crystalline substance soluble in water.

Frangulinic Acid, a Derivative from Anthracen.—A. Faust.—By treating frangulinic acid, $C_{14}H_{10}O_5+H_2O$, with zinc-dust at a high temperature anthracen was obtained; and consequently the author states that he is now busy with experiments to ascertain whether the formula of the acid just alluded to should be—

$$C_{14}H_7(OH)_3O_2 \text{ or } C_{14}H_8(OH)_2O_2.$$

Journal für Gasbeleuchtung und Wasserversorgung, No. 20, 1871.

This number does not contain any original papers other than those relating to gas- and water-works' management and engineering, but we call attention to the—

Gas-Meter Testing Regulations of the North German Confederation, and Instruction to the Gas-Meter Inspectors.—Evidently arranged with very great care and extensive scientific, as well as sound practical, knowledge on this subject.

Annalen der Chemie und Pharmacie, October, 1871.

This number contains the following original papers and memoirs:—

Dissociation and Restoration (Rückbildung) of Carbamate of Ammonium.—A. Naumann.—This exhaustive memoir, elucidated by a series of tabulated forms, contains the following sections:—Introductory observations; experimental proof of the non-volatility of carbamate of ammonium in undecomposed state; density of the gases derived from carbamate of ammonium; mode of experimenting on, observing, and of making the required corrections in phenomena attending the dissociation of carbamate of ammonium; dissociation and rapidity of re-construction of carbamate of ammonium at the ordinary temperature, at 34°, 42°, 46°, and at 20°; rapidity of dissociation of carbamate of ammonium at −3·8°.

Combinations of Oxide of Bismuth with Sulphuric Acid.—A. Leist.—After first referring to the researches of Dr. Heintz made twenty-seven years ago, and published in *Pogg. Ann.*, vol. lxiii., p. 77, and the researches lately made by Dr. Schultz-Sellack on this subject, the author describes at length the mode of preparation and properties of the following compounds of oxide of bismuth and sulphuric acid:—$Bi_2O_3,4SO_3+9H_2O$, in 100 parts—Oxide of bismuth, 49·05; sulphuric acid, 33·83; water driven off at 110°, 12·420; water driven off at red heat, 6·387. $4Bi_2O_3,3SO_3+15HO$, in 100 parts—Oxide of bismuth, 78·040; sulphuric acid, 9·80; water at 110°, 3·539; water at red heat, 8·621. $Bi_2O_3,2SO_3+2H_2O$, in 100 parts—Oxide of bismuth, 69·023; sulphuric acid, 25·499; water at 110°, 4·291; water at red heat, 1·187.

Diethyliden-Lactamidic Acid.—Dr. W. Heintz.—By a rather complicated and not very clearly described process, the author first prepares diethyliden-lactamidate of copper, which, having been treated with hydrosulphuric acid, yields diethyliden-lactamidic acid, which is obtained from its aqueous solution in small-sized needle-shaped crystals, soluble in dilute but not in absolute alcohol. The crystals are anhydrous, and consist of $C_6H_{11}NO_4$; the formula of the copper salt is $C_6H_9CuNO_4$.

Behaviour of Starch and Dextrine towards Iodine and Tannic Acid.—V. Griessmayer.—The contents of this lengthy essay record a series of experiments made with the view to elucidate the reactions of the bodies alluded to.

Derivatives from Phthalic Acid.—A. Faust.—This exhaustive essay is divided into the following sections:—Introduction; nitrophthalic acid and its salts; amido-benzoic acid from nitro-phthalic acid; bromo-phthalic acid and salts; dichloro-phthalic acid and salts.

Derivatives from Naphthaline.—A. Faust and E. Saame.—This memoir contains two main sections, viz., the description of the products of addition to naphthaline, and that of the substitution-products of naphthaline; but, notwithstanding the high scientific value of this, as well as of the foregoing memoir, it is not well suited for useful abstraction, an observation also applying to the following exhaustive and very lengthy memoir.

Origin and Properties of Monochlor-Citramalic Acid.—J. Gottlieb.—Introduction; monochlor-citramalic acid hydrate; salts of monochlor-citramalic acid.

NOTES AND QUERIES.

Coagulation of Clay.—Can any of your readers refer me to information respecting the coagulation of clayey water by the addition of salts or other ingredients. It is well known that alum will do this, but I want to know if experiments are on record tried with other substances?—X. Y. Z.

Twaddell and Beaumé.—In answer to J. W.'s query, to obtain the sp. gr. of a liquid by Twaddell's hydrometer, multiply the number of degrees by 5 and add 1000 to the product; for instance—

$$115\times5=575+1000=1575 \text{ sp. gr.}$$

Exact specific gravities can only be determined by weighing.—H. B. YARDLEY.

Specific Gravity.—(Reply to J. W.)—The degrees of Twaddell are easily turned into sp. gr. numbers, a quality which makes it preferable to any other hydrometer in use. The rule is to multiply the indicated degree by 5 and add 1000 to the product; for example, 9° Tw. = 1·045 sp. gr., 25° Tw. = 1·125 sp. gr. To bring specific gravities to degrees of Twaddell, substract 1000 and divide the remainder by 5; for example, 1·100 sp. gr. = 20° Tw. An instrument so much in use should be correct in its indications, but there are very erroneous ones offered for sale, and purchasers should only trust to an instrument made by some well-known and established house.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 4th.—London Institution, 4. Prof. Huxley, LL.D., F.R.S., on "The Physiology of Bodily Motion and Consciousness" (VI.).
—— Medical, 8.
—— Royal Institution, 2. General Monthly Meeting.
—— Anthropological, 8.
TUESDAY, 5th.—Civil Engineers, 8.
—— Zoological, 9.
WEDNESDAY, 6th.—Society of Arts, 8.
—— Geological, 8.
—— Microscopical, 8.
—— Pharmaceutical, 8.
THURSDAY, 7th.—London Institution, 7.30. Paper and Discussion.
—— Chemical, 8. Dr. Gladstone, "On Essential Oils."
—— Royal, 8.30.
—— Royal Society Club, 6.
FRIDAY, 8th.—Astronomical, 8.
—— Quekett Microscopical Club, 8.

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CHRISTMAS LECTURES (adapted to a Juvenile Auditory).

PROFESSOR TYNDALL, LL.D., F.R.S. Six Lectures. "On Ice, Water, Vapour, and Air." On December 28th and 30th, 1871; January 2nd, 4th, 6th, and 9th, 1872.

BEFORE EASTER, 1872.

Dr. W. RUTHERFORD, F.R.S.E. Ten Lectures. "On the Nervous and Circulatory Systems." On Tuesdays, January 16th to March 19th.

PROFESSOR ODLING, F.R.S. Ten Lectures. "On the Chemistry of Alkalies and Alkali Manufacture." On Thursdays, January 18th to March 21st.

W. G. DONNE, Esq. Six Lectures. "On Literature." On Saturdays, January 20th to February 24th.

MONCURE D. CONWAY, Esq. Four Lectures. "On Demonology." On Saturdays, March 2nd to 23rd.

The Friday Evening Meetings will commence on January 13th.

The Friday Evening Discourses *before Easter* will *probably* be given by Mr. W. R. Grove, Q.C., the Archbishop of Westminster, Professors Odling and Humphry, Dr. Gladstone, Messrs. C. W. Siemens, R. Liebreich, and John Evans, and Professor Tyndall.

To the Friday Evening Meetings Members and their Friends only are admitted.

AFTER EASTER.

Dr. WILLIAM A. GUY, F.R.S. Three Lectures. "On Statistics' Social Science, and Political Economy." On Tuesdays, April 9th' 16th, and 23rd.

EDWARD B. TYLOR, Esq., F.R.S. Six Lectures. "On the Development of Belief and Custom amongst the Lower Races of Mankind." On Tuesdays, April 30th to June 4th.

PROFESSOR TYNDALL, LL.D., F.R.S. Nine Lectures. On Thursdays, April 11th to June 6th.

R. A. PROCTOR, Esq., B.A., F.R.A.S. Five Lectures. "On Star Depths." On Saturdays, April 13th to May 11th.

PROFESSOR ROSCOE, F.R.S. Four Lectures. "On the Chemical Action of Light." On Saturdays, May 18th to June 8th.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 628.

CONTRIBUTIONS TO THE HISTORY OF THE OPIUM ALKALOIDS.*

By C. R. A. WRIGHT, D.Sc.,
Lecturer on Chemistry in St. Mary's Hospital Medical School.

(Concluded from p. 257).

3. *Action of Sodium Carbonate on the Compound* $C_{68}H_{86}I_2N_4O_{12},4HI$.

On adding sodium carbonate to the scarcely warm aqueous solution of this compound a voluminous white precipitate is produced, which is apparently a mixture of three bases, two of which contain iodine, whilst the third is free from that ingredient. The first one, which forms only a small fraction of the whole, is the free base of the original compound, $C_{68}H_{86}I_2N_4O_{12}$; this is readily soluble in ether, and may be obtained as hydriodate (as previously stated) by digesting the precipitate with ether, and agitation of the extract with hydriodic acid, whereby the original substance is reproduced. To prevent frothing, the precipitate must be well drained from the aqueous portion. By continuing the extraction until some 6 litres of ether have been employed for exhausting the precipitate from 40 grms. of original substance, the whole of this base is removed, or nearly so. Attempts to prepare the base itself by evaporation of the ether yielded only a tarry substance which could not be removed from the vessel employed; treatment with water or alcohol more or less decomposes it.

By employing a large bulk of ether after this first base has been almost wholly removed, an extract is obtained from which on evaporation solid flakes separate; these are much less soluble in ether than the first base, and after drying at 100° gave the following numbers, indicating the formula $C_{68}H_{81}IN_4O_{10}$.

0·1985 grm. gave 0·4705 CO_2 and 0·119 H_2O.
0·1210 grm. gave 0·2600 AgI.

	Calculated.		Found.
C_{68}	816	65·81	64·65
H_{81}	81	6·53	6·66
I	127	10·24	11·61
N_4	56	4·52	
O_{10}	160	12·90	
$C_{68}H_{81}IN_4O_{10}$	1240	100·00	

Apparently these flakes still retained a trace of the first base; the mother-liquor from which they separated, when evaporated to dryness, left a small amount of residue containing 14·18 per cent of iodine. Treated with hydriodic acid, these flakes gave a hydriodate yielding these numbers after drying at 100°:—

0·3675 grm. gave 0·6335 CO_2 and 0·181 H_2O.
0·371 grm. gave 0·2405 AgI.

	Calculated.		Found.
C_{68}	816	46·58	47·00
H_{85}	85	4·85	5·47
I_5	635	36·24	35·02
N_4	56	3·20	
O_{10}	160	9·13	
$C_{68}H_{81}IN_4O_{10},4HI$	1752	100·00	

* Read before the Royal Society, November 16, 1871.

Evidently a slight loss of iodine has occurred from the action of the adhering moisture while drying, as the original flakes contained rather too high a percentage of iodine. This base is formed from the original one by the reaction—

$$C_{68}H_{86}I_2N_4O_{12},4HI = 2H_2O + HI + C_{68}H_{81}IN_4O_{10},4HI,$$

identical with that taking place on treatment with water.

A portion of the substance left after extraction with ether was treated several times successively with large bulks of ether (about 4 litres of ether to 10 grms. of precipitate each extraction). After the majority of the substance had thus been dissolved, a portion of the last ether extracts was evaporated down and yielded flakes agreeing approximately with the composition required for a mixture of 1 molecule of $C_{68}H_{81}IN_4O_{10}$, and 2 molecules of $C_{68}H_{80}N_4O_{10}$.

0·3565 grm. gave 0·926 CO_2 and 0·237 H_2O.
0·376 grm. gave 0·255 AgI.
0·2455 grm. gave 0·170 AgI.

	Calculated.	Found.	
C	70·67	70·84	
H	6·96	7·39	
I	3·67	3·66	3·73

From the foregoing experiments it is clear that the action of sodium carbonate on the compound

$C_{68}H_{86}I_2N_4O_{12},4HI$

is identical with that of water described in (2), the two bases, $C_{68}H_{81}IN_4O_{10}$ and $C_{68}H_{80}N_4O_{10}$, being the principal products.

On precipitating in a similar way the compound

$C_{68}H_{82}I_2N_4O_{10},4HI$,

the same reaction appears to take place; from the precipitate ether extracts only traces at first, indicating probably that the base $C_{68}H_{82}I_2N_4O_{10}$ is not produced in any quantity; as apparently the more highly iodised bases are more soluble in ether.

On treating the compound $C_{68}H_{82}I_2N_4O_{6,4}HI$ in the same way, an analogous reaction seems to ensue; the precipitate is very sparingly soluble in ether, and on treatment with hydriodic acid furnished a hydriodate of which 0·233 grm. dried at 100° gave 0·142 AgI; hence I = 29·94 per cent; the compound $C_{68}H_{88}N_2O_{10},4HI$ requires 31·13 per cent, whilst the original substance requires 40·53 per cent.

4. *Action of Hydriodic Acid on some of the foregoing substances.*

As the action of water on the three compounds first described is to remove the elements of HI associated with the carbon radicals of the bases, it was thought probable that by treating the products of the action of water on these compounds with strong boiling hydriodic acid, the HI thus lost might be again added on. A reaction of this nature does indeed take place, but does not always stop at the reproduction of the original bodies, another equivalent of HI being also added on; moreover, in some instances a number of molecules of H_2O are likewise taken up, and are not separated from the compounds ultimately formed even by some days' exposure to a temperature of 100°.

On treating the compound $C_{68}H_{80}N_4O_{10},4HI$ with about ten parts of 55 per cent of hydriodic acid (a little piece of phosphorus being also added to prevent separation of iodine from the HI by the heat) and heating to boiling, a syrupy liquid is obtained, from which water precipitates (after filtration of phosphorus) a tar resembling in all its physical characters the compound $C_{68}H_{86}I_2N_4O_{12},4HI$; it contains, however, the elements of $HI + 10H_2O$ more than this substance. The same substance apparently is generated by treating the intermediate compound

$C_{68}H_{81}IN_4O_{12},4HI$

with hydriodic acid in the same manner.

(A.) From the compound $C_{68}H_{80}N_4O_{10},4I$; dried at 100° till constant:

0·3565 grm. gave 0·483 CO_2 and 0·158 H_2O.
0·3835 grm. gave 0·278 AgI.

(B.) (A) dried twelve hours more at 100°, had turned a much darker colour, probably indicating absorption of oxygen:

0·329 grm. gave 0·434 CO_2 and 0·155 H_2O.
0·561 grm. gave 0·419 AgI.

(C.) From the compound $C_{68}H_{81}IN_4O_{10},4HI$:

0·377 grm. gave 0·485 CO_2 and 0·175 H_2O.
0·387 grm. gave 0·2855 AgI.

	Calculated.		Found. A.	B.	C.	Mean.
C_{68}	816	36·69	36·95	35·98	35·09	36·01
H_{111}	111	4·98	4·93	5·24	5·16	5·11
I_7	889	39·98	39·16	40·35	39·87	39·79
N_4	56	2·52				
O_{22}	352	15·83				
	2224	100·00				

$C_{68}H_{107}I_3N_4O_{22},4HI$.

Hence this body is formed by the equations—

$$C_{68}H_{80}N_4O_{10},4HI+3HI+12H_2O=$$
$$=C_{68}H_{107}I_3N_4O_{22},4HI.$$
$$C_{68}H_{81}IN_4O_{10},4HI+2HI+12H_2O=$$
$$=C_{68}H_{107}I_3N_4O_{22},4HI.$$

On treating the compound $C_{68}H_{88}I_3N_4O_{10},4HI$ in the same way a product is obtained only differing from the original substance by one equivalent of HI; dried at 100°:

0·3995 grm. gave 0·6800 CO_2 and 0·197 H_2O.
0·3215 grm. gave 0·2200 AgI.

	Calculated.		Found.
C_{68}	816	46·36	46·41
H_{93}	93	5·28	5·48
I_5	635	36·09	36·97
N_4	56	3·18	
O_{10}	160	9·09	
$C_{68}H_{89}IN_4O_{10},4HI$	1760	100·00	

Hence this body appears to have been formed by the reaction $C_{68}H_{88}N_4O_{10},4HI + HI = C_{68}H_{89}IN_4O_{10},4HI$, no water having been taken up; whilst in the case of the other non-iodised base, 3 molecules of HI and 12 of H_2O are assimilated.

In order to see if the combined action of phosphorus and hydriodic acid would transform the compound

$$C_{68}H_{86}I_2N_4O_{12},4HI$$

into the body $C_{68}H_{82}I_2N_4O_6,4HI$, the former compound was dissolved in about 10 parts of 55 per cent hydriodic acid, and boiled until most of the acid had volatilised; a considerable quantity of phosphoric acid was formed during the reaction, and on precipitating the compound produced with water, and drying at 100°, the following numbers were obtained:—

0·2795 grm. gave 0·3900 CO_2 and 0·136 H_2O.
0·4195 grm. gave 0·327 AgI.
0·4225 grm. gave 0·333 AgI.

	Calculated.		Found.	
C_{68}	816	38·42	38·06	
H_{107}	107	5·04	5·41	
I_7	889	41·85	42·12	42·59
N_4	56	2·64		
O_{16}	256	12·05		
$C_{68}H_{103}I_3N_4O_{16},4HI$	2124	100·00		

From these numbers it appears that the substance produced may be considered as formed by the reactions,

$$C_{68}H_{86}I_2N_4O_{12},4HI+8HI=$$
$$=I_8+6H_2O+C_{68}H_{82}I_2N_4O_6,4HI.$$
$$C_{68}H_{82}I_2N_4O_6,4HI+HI+10H_2O=$$
$$=C_{68}H_{103}I_3N_4O_{16},4HI.$$

It is not easy to explain why the reaction should stop short at the end of the first stage, when codeia is treated with hydriodic acid and boiled up to 130°; possibly the presence of a much larger quantity of phosphorus acids in this case may tend to prevent the second reaction ensuing.

5. *Discussion of the Foregoing Results.*

From the complex constitution of the substances described above, it is at present thought unadvisable to attempt to give names to them. All the bodies previously mentioned may be regarded as being derived from one or other of the two bases $C_{17}H_{21}NO_3$ and $C_{17}H_{21}NO_2$ by multiplication of the molecule, and addition or subtraction of the elements of water and of hydriodic acid.

These two (hypothetical) bases contain H_2 more than morphia and deoxymorphia respectively; denoting the first by the symbol X, and the second by Y, the following general formulæ will indicate all the compounds previously described:—

$$4X+mHI\pm nH_2O,$$
$$4Y+mHI\pm nH_2O.$$

Thus the following table illustrates the mutual relations of the compounds described:—

Source of Compound.	Formulæ.
(A) Codeia, HI, and P at 150°.	$C_{68}H_{80}I_4N_4O_{12},4HI=4X+6HI$
(B) Do. 110° to 115° ..	$C_{68}H_{82}I_2N_4O_{10},4HI=4X+6HI-2H_2O.$
(C) (A) treated with water or Na_2CO_3..	$C_{68}H_{81}IN_4O_{10},4HI=4X+5HI-2H_2O.$
(D) Free base of (C). (A) treated with Na_2CO_3	$C_{68}H_{81}IN_4O_{10}=4X+HI-2H_2O.$
(E) Further action of water on (C)	$C_{68}H_{80}N_4O_{10},4HI=4X+4HI-2H_2O.$
(F) Action of HI on (E)	$C_{68}H_{107}I_3N_4O_{22},4HI=4X+7HI+10H_2O.$
(G) Codeia, HI, and P at 135°	$C_{68}H_{82}I_2N_4O_6,4HI=4Y+6HI-2H_2O.$
(H) Action of water on (G)	$C_{68}H_{83}N_4O_{10},4HI=4Y+4HI+2H_2O.$
(I) Action of HI on (H)	$C_{68}H_{89}IN_4O_{10},4HI=4Y+5HI+2H_2O.$
(J) Action of HI on (A)	$C_{68}H_{102}I_3N_4O_{16},4HI=4Y+7HI+8H_2O.$

Although it may well happen that further researches may show that some of the above formulæ require some slight correction, the analytical numbers not always agreeing together absolutely accurately, yet the following points may be considered established:—

(1). The action of hydriodic acid on codeia polymerises it, the ultimate compounds formed being derived from at least four molecules of codeia. Hydrobromic acid also polymerises codeia, but not so completely as hydriodic acid, there being found, in addition to the tetra-bases, compounds which (from their crystalline character and other physical properties) are apparently derived from 1 molecule only of codeia. Hydrochloric acid does not appear to have a marked polymerising effect on codeia.

(2). Hydriodic, hydrobromic, and hydrochloric acids all eliminate methyl from codeia, forming ultimately compounds containing nC_{17}.

(3). The compounds got by the action of hydriodic acid in presence of phosphorus indicate that the carbon groups contained in codeia are in an eminently "unsaturated" condition, being capable of taking up several molecules of HI and of H_2O, forming compounds not decomposed at 100°; 2 equivalents of hydrogen for every C_{17} being also added on in every case.

ASSAY FOR GOLD AND SILVER.

By T. M. BLOSSOM, E. M.

(Continued from p. 44).

4. *Weighing the Bead.*—The bead of gold and silver is detached from the cupel with pincers, thoroughly cleansed, and weighed. The balance used for this purpose is exceedingly delicate, it being possible to read with it down to tenths of a milligramme.

5. *Inquartation and Parting.*—The separation of gold from silver is termed *parting*. It is effected, generally, by means of nitric acid, which dissolves the silver and leaves the gold, in the assay of ores, in a loosely adherent spongy mass, or a dull powder. It is essential that a certain relation should exist between the amount of gold in the alloy and that of the silver. If there be too little silver present, it will not be dissolved completely, but a part of it will be so enveloped in the gold as to escape the action of the strongest acid. If, on the other hand, too much silver be present, the gold is too highly diluted, and is obtained in leaves so fine and light as to occasion a loss in the subsequent washing. The silver should be from 2·5 to 3 times the amount of gold. The assayer must judge by the colour of the bead as to the proportion of silver contained; and if it be too small he must supply the deficiency with pure silver. In assaying ores, no attempt is made at an adjustment when the silver is in excess, but great care is necessary in the parting. This is a matter of more importance in bullion assay. This adjustment of the proportion of silver is called "Inquartation" or "Quartation," and will be treated more fully under "Assay of Alloys." Silver is kept on hand in thin foil, from which little bits can easily be cut with pliers. The bead and the silver are fused well together, to effect complete distribution of the silver. The fusion is made most conveniently on charcoal by means of the blowpipe, if a few beads only are being treated. If a large number are to be treated, it may save time to wrap the bead and silver in a cornet of lead-foil and cupel it, since several can be fused at the same time. The inquartated bead is flattened on the anvil and treated in a porcelain capsule with pure nitric acid of 1·16 sp. gr. Enough acid is added to cover the bead completely. Heat gently, taking care not to boil violently and scatter the gold. It is to prevent the occurrence of the latter that we do not employ at first a very strong acid, which might create too brisk an action and break up the gold. The acid must be free from chlorine, which would precipitate the silver. When all action of the first acid has ceased, it is decanted gently, and some fresh acid of 1·26 sp. gr. is added. Heat for several minutes, then pour off the acid, wash thoroughly with distilled water and dry the residue of gold. It is well to apply a high heat before attempting to remove the gold, for the spongy mass is thus rendered adherent and may be removed without crumbling. The gold residue is now detached with a knife, transferred to a cornet of lead, and cupelled.

6. *Weighing the Gold Bead.*—The gold bead obtained from the last cupellation is weighed, and the assay is completed. It remains only to calculate the results.

Calculation of Results.

This is a simple operation and hardly needs explanation. As already stated, the milligrammes of precious metal obtained per assay ton of ore correspond to ounces in the ton of 2000 lbs. av. Let us take, however, the special example of an ore containing metallic gold or silver finely disseminated throughout the ore, and occurring in scales which remain upon the sieve. This will embrace and suggest all cases likely to arise in ordinary practice. It may be necessary to state here, that the treatment of the scales consists only of a cupellation, or of scorification and cupellation combined, according to the nature of the material (Assay of Alloys).

Let us suppose that the sample presented for assay gave, on being pulverised and passed through a sieve of 80 meshes to the linear inch, the following weights:—

A. Sifted ore	1458·32 grms.
B. Scales of metal	40·75 ,,
C. Total	1499·07 grms.

It being known from the mineralogical composition of the sample that it was a rich ore, ½ A.T. was taken for an assay of the sifted portion (A). The residue of metallic scales, &c. (B), was scorified with test-lead, and yielded a button weighing 60·35 grms. of the lead alloy. This button was rolled out, and two average samples, of 10 grms. each, were cupelled.

The following results were obtained from the complete assays:—

A. SIFTED ORE.—*Crucible Assay.*

One-third assay ton, 9·722 grms., yielded:—

	1.	2.	Average.
Au + Ag.	0·19355	0·19275	0·19315
Au (by parting)	0·00025	0·00025	0·00025
Ag.	0·19330	0·19250	0·19280
Ag in litharge*	0·00067	0·00067	0·00067
Ag. in ore	0·19263	0·19183	0·19213

B. METALLIC SCALES.

Ten grms. of the scorified button yielded—

	1.	2.	Average.
Au + Ag.	5·0625	5·0620	5·0622
Au (by parting)	0·0020	0·0020	0·0020
Ag.	5·0605	5·0600	5·0602
Ag. in test-lead	none	none	none

A. Sifted ore .. $1458{\cdot}32 \times \frac{0{\cdot}19213}{9{\cdot}722} = 28{\cdot}819$ Ag.

B. Metallic scales $40{\cdot}75 \; \frac{5{\cdot}0602}{10} \times 60{\cdot}35 = 30{\cdot}538$ Ag.

C. Total ore .. 1499·07 59·357 T'l Ag.

$29166{\cdot}66 \times \frac{59{\cdot}357}{1499\,07}$ 1154·71 ozs. per 2000 lbs.

A. Sifted ore .. $1458\,32 \times \frac{0{\cdot}00025}{9{\cdot}722} = 0{\cdot}0375$ Au.

B. Metallic scales $40{\cdot}75 \; \frac{0{\cdot}002}{10} \times 60{\cdot}35 = 0{\cdot}0121$ Au.

C. Total ore .. 1499·07 0·0496 T'l Au.

$29166{\cdot}66 \times \frac{0{\cdot}0496}{1499{\cdot}07} = 0{\cdot}97$ czs. per 2000 lbs.

RESULT PER 2000 LBS. ORE.

	Ozs.		Dols.	Dols.
Silver	1154·71	at	1.29 ..	1489.58
Gold	0·97	at	20.67 ..	20.04
Total bullion	1155.97			1509.62

GALENA.—*Special Method.*—It is best and most convenient always to make a scorification assay of galena. If, however, it be desirable for any reason to make a crucible assay, a charge of nitre and carbonate of soda is

* The litharge yielded 1 milligrm. silver per assay ton, and two-thirds assay ton were employed.

generally employed instead of roasting the ore. Twenty grms. of nitre per assay ton of ore are required for pure galena; this amount diminishing, of course as the gangue increases in quantity, or the amount of sulphur is lessened. Employ the same weight of carbonate of soda as of ore. If there be any doubt as to the amount of nitre required, make a preliminary assay with an assumed charge, and modify the regular charge according to the result.

Concluding Remarks concerning the Assay of Ores.

Any of the substances mentioned under the head of "Ores and Minerals" can be assayed by either the foregoing methods (*a*) Crucible and (*b*) Scorification. There is only one practical limit in the case of scorification involved, as before mentioned, in the richness of the ore. The latter method is preferable whenever it can be used conveniently. It yields higher results and requires no preliminary assay. There is a roasting period in the operation, but it is simple, and is free from many of the disagreeable features of a preliminary roasting. No oxysulphurets are formed, or, if formed, are decomposed during the operation; whereas, in the crucible assay, they may escape decomposition, even at a white-heat. It is a better method for very rich copper ores; the action of scorification is oxidising, that of the crucible reducing; hence, in the latter case, much copper will enter the lead-button that, in the former case, would be oxidised and enter the slag.

NOTE ON THE SPECTRUM OF THE AURORA.

By G. F. BARKER.

On the evening of November 9th, there appeared one of the most magnificent crimson auroras ever seen at this place. When first observed, at about a quarter before six, p.m., it consisted of a brilliant streamer shooting up from the north-western horizon; this was continued in a brilliant red, but rather nebulous, mass of light, passing upward and to the north. Its highest points were from 30° to 40° in altitude. A white aurora, consisting of bright streamers, appeared simultaneously, and extended round to the north-east.*

The crimson aurora was examined with a spectroscope at six o'clock. The instrument used was a single glass-prism spectroscope, made by Duboscq, of Paris. On directing the slit towards the brilliant streamer above mentioned, a bright spectrum was observed, consisting of five well-marked lines. A millimetre scale attached to the instrument was then illuminated with a gas-flame, the auroral lines being readily measured, even when the numbers on the scale were bright enough to be read distinctly. The sodium line was used to adjust the scale, being equally divided by the division 100; the width of the slit was about one millimetre. As thus arranged, the five auroral lines, beginning at the red end, had the following positions:—Scale-Nos. 90, 110·5, 130, 138, 149. The brightness of the lines was, following the above order, 3, 1, 5, 2, 4, the second line from the red end of the spectrum being the brightest. The line marked 90 and the one marked 110·5 were sharp and well-defined; the others were all nebulous on the edges.

Before the measurements were completely verified by a second comparison, the crimson aurora entirely vanished, having endured less than a half hour. In the white aurora which remained, the spectroscope showed four of the five lines given; the crimson line alone was absent. The measurements are exact to half a division of the scale.

To determine the approximate wave-length of these lines comparison was made both with certain metallic lines and with the lines of the solar spectrum. On the scale of this instrument, the metallic lines employed read as follows:—

Kα 63. Liα 79. Srβ 80. H(*c*) 82, Caα 91, Srα 96, Caβ 113, H(*f*) 146·5, Srδ 163, Csβ 165, Csα 167, Rbα and β 200, Kβ 218.

The Fraünhofer lines measured as follows:—

a 70·5, B 76, C 82, D 100, E 124·5, *b* 130, F 146·5, G 189.

Direct interpolation was used in comparing the wave-length of the auroral lines with those given above, the wave lengths of the Fraünhofer and elemental lines being taken from Gibbs's tables (*Am. Journ. Sci.*, II., xliii., 1; xlvii., 194). This method was believed capable of giving results as close as the instrumental measurements. In this way the wave-lengths of the five auroral lines were obtained as given in the following table:—

Line.	Scale number.	Wave-length.	Auroral lines.	Other measurements.
B	76·0	687		
C	82 0	656		
(1)	90·0	623	623	627 Zöllner.
D	100·0	589		
(2)	110·5	562	562	556 Angström.
E	124·5	527		
(3)	130·0	517	517	520 Winlock.
b	130·0	517		
(4)	138·0	502	502	
F	146·5	486		
(5)	149·0	482	482	485 Alvan Clark, Jr.
G	189·0	431		

In this table, column 1 gives the auroral and the Fraünhofer lines; column 2, the number of these are measured upon the scale of the spectroscope used; column 3, the wave-lengths of these lines obtained as above stated; column 4, the wave-lengths of the auroral lines, given by themselves; and column 5, the wave-lengths of what I assume to be the same lines, with their wave-lengths as measured by the observers mentioned.

The point of particular interest in this observation is the fact that the line (4) of wave-length 502 is not laid down in any authority accessible to me as having been observed in the auroral spectrum. Indeed, no previous observer, so far as I know, has seen any auroral line between the Fraünhofer lines *b* and F. Professor C. A. Young (*Am. Journ. Sci.*, III., ii., 332, Nov. 1871) gives two lines—Nos. 56 and 57, or 1866·8 and 1870·3 of Kirchhoff—observed by him in the sun's chromosphere and also by Rayet in the eclipse of 1868, one of which may coincide with this fourth auroral line.—*American Journal of Science.*

New Haven, Nov. 13, 1871.

* Professor Newton informs me that he observed an equally brilliant red patch of auroral light in the north-east, five or ten minutes earlier. Since the lower end of the red streamers was much lower than that of the white, it would seem as if the red were seen through the white, the red being most remote.

ON THE

EVAPORATION TO DRYNESS OF GELATINOUS PRECIPITATES.

By THOMAS M. CHATARD.

In a former paper* I called attention to the fact that many gelatinous precipitates, when evaporated to dryness, became very granular and easy to filter. I gave some examples then and have since tested several others.

* *Am. Journ. Sci.*, vol. i., p. 247.

Titanic Acid.—Rutile was fused with sodic disulphate, the titanic acid precipitated by ammonic hydrate and evaporated to dryness. It became quite sandy and washed with great rapidity and thoroughness.

Glucina.—Pure glucina was dissolved in chlorhydric acid, precipitated by ammonic hydrate and exaporated to dryness. In this case, as glucina is soluble in ammoniacal salts, it was necessary to ignite the dry mass to expel these. This was done in the platinum dish in which the evaporation was carried on. The residual glucina was sandy and washed with great ease; *zirconic*, *niobic*, and *tantalic acids* when thus treated gave results which were all that could be desired.

Ceric, lanthanic, and didymic oxalates, when treated with sulphuric acid, and ammonic hydrate added, gave also perfectly satisfactory results.

In conclusion, there seems to be no doubt that almost any gelatinous precipitate can be successfully treated in this manner.—*American Journal of Science.*

HERRESHOFF'S METHOD FOR VALUING BLEACHING-POWDER.

By A. H. MASSEY,
Student at King's College, London.

THE standard solutions were the same in every respect as those described in the CHEMICAL NEWS (vol. xxiii., p. 293). The method of preparing the solution of powder consisted in weighing 10 grms. of the sample and triturating in a mortar with water. The solution so obtained was poured into a graduated flask, and filled up to one litre. The clear liquid was drawn off, 100 c.c. were taken, 50 to 100 c.c. of water and 10 c.c. of hydrochloric acid added. A few drops of starch and iodide of potassium prepared the solution for titration with potassic dichromate.

Four samples of the same powder gave the following percentages of available chlorine :—

24·92 per cent.
24·70 ,,
24·80 ,,
25·00 ,,

The author has not found any difficulty in purifying arsenious acid by sublimation, or in preparing solutions of arsenite of soda for volumetric estimations of chlorine.

Three samples of the same powder previously valued by Herreshoff's method gave by Penot's method the following results :—

Active Chlorine.
24·76 per cent.
24·70 ,,
24·59 ,,

These numbers show that both processes may be considered equally accurate.

ON THE GASES OCCLUDED IN COAL.

By Dr. E. MEYER.

I DESIRE this paper to be considered only as a preliminary notice, it being my intention to extend these researches. Since, so far as I am acquainted, the question whether any at all, and, if so, what kind of gases are occluded in coal has not been experimentally dealt with, it occurred to me to test Zwickau coals (Saxony) in this respect.

Lumps of hard and compact coal the size of a walnut were put into a flask, previously partly filled with thoroughly well-boiled and hot distilled water, the flask was next closed with a perforated caoutchouc stopper wherein a glass tube was fitted, which, serving as gas-conveying tube, was carried into a vessel filled with water deprived of air. The apparatus thus arranged was kept at boiling heat for some time in order thereby to eliminate the film of air which mechanically adheres to the coal. The boiling was further continued after the gas-conducting tube had been placed over a graduated glass tube, previously filled with distilled water freed from air and placed on a pneumatic trough. The gas thus collected (constantly evolved from the lumps of coal) was analysed according to Bunsen's method, and found to consist in the first sample operated upon, percentically, of:—Carbonic acid, 16·9; marsh-gas, 20·4; nitrogen, 53·3; oxygen, 1·7; heavy carburetted hydrogens absorbable by fuming sulphuric acid 7·7. Second sample—Carbonic acid, 22·4; marsh-gas, 22·3; nitrogen, 48·0; oxygen, 4·1; heavy carburetted hydrogens absorbable by fuming sulphuric acid. The large quantity of nitrogen and the small quantity of oxygen deserve special notice. The samples of coal experimented with had been kept in a cellar for a period of several months in contact with air so that it would appear that the oxygen of the air absorbed has served for the oxidation of the coal and formation of carbonic acid.

I may not also neglect to call attention to the heavy carburetted hydrogens which, as far as I am aware, have not been hitherto noticed as being occluded in coal. It might be surmised, yet it is very improbable, that these heavy carburetted hydrogens have been formed by the heating of the coal under water at 100°. I intend to elucidate this point by exhausting the gases from coal with the aid of a mercurial air-pump at the ordinary temperature of the air in order to ascertain whether the same kind of coal will then also yield carburetted hydrogens absorbable by fuming sulphuric acid. These researches will be continued and extended to other kinds of coal. The results of my experiments I shall publish at a future date.—*Journal für Praktische Chemie.*

NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

VI.

I PURPOSE here classifying briefly the various data obtained at previous demonstrations, so that they may be applied for clinical purposes or otherwise to the fluids and solids of animal production.

Fluids.

(α). Note whether any solid particles are suspended, and if so, filter; frequently in hydrocele and ovarian cyst fluids, fibrin in flocculi, or plates of cholesterine occur.

(β). Observe the colour; if practicable apply spectroscope. The most frequent pigments are those of blood and bile; blood may be distinguished by the microscope, and bile by adding HNO_3, which causes chameleonic changes of colour.

(γ). Take the sp. gr. if possible by some form of hydrometer; many fluids require the sp. gr. bottle for accurate determination. If much fat be present, as in milk, the sp. gr. does not indicate much of importance.

(δ). Evaporate a portion to dryness, and incinerate the residue, testing the ash in the ordinary way or by the spectroscope.

(ε). Ascertain whether acid or alkaline with test-papers if acid, albuminous bodies will probably be absent; i alkaline, note whether from putrefaction.

(ζ). Add HCl to the fluid; if a precipitate occur, slightly acidulate a portion of the original and boil; a precipitate

indicates albumin. If no precipitate occurs on boiling, add acetic acid; a precipitate indicates casein. If, however, a precipitate did occur in the original fluid on boiling, then filter, and treat the filtrate as above.

(η). Evaporate a portion of the liquid, freed from albuminous matter, to ¼th of its original bulk; if allantoin be present it will separate, as will leucin; add HCl, if hippuric or uric acids be present they will precipitate. Hippuric acid on burning gives off fumes of benzoic acid; uric acid is proved by the murexid test.

(θ). Evaporate a portion to dryness, powder, and boil with ether or benzol to remove fat.

Palmitin, stearin, and olein saponify, whilst cholesterin and serolin (?) do not.

(ι). Evaporate to ¼th bulk, and add HNO_3; if urea be present it separates as nitrate of urea; alcohol takes up urea, bilin, &c.

(κ). Proof-spirit takes up sugars, NaCl, &c. The presence of sugar in the spirit extract may be proved by the formation of melassic acid with KHO, also with the copper test.

The application of these principles is exceedingly simple, and, though anything but a delicate system of analysis, will yield very useful results to the inquirer.

A few watch-glasses, some test-tubes, a piece of platinum foil, a urinometer, and some filtering and test-papers, are all the apparatus needed for ordinary work of this kind.

Solids.

These are generally pathological products, but a very similar course may be applied to their analysis, thus:

First incinerate to ascertain if wholly organic, and then boil successively in water, alcohol, spirit, benzol, acid (acetic), and alkali, and to the products apply the test as directed above.

LETTERS FROM M. LAVOISIER TO DR. BLACK.

THROUGH the kindness of Professor Andrews, we are able to publish the letters to which he referred in his address to the Chemical Section of the British Association, October 3rd, 1871. The following passage from Dr. Andrews's address forms a fitting introduction to these letters:—

"Whatever may be the true value of the Stahlian views, there can be no doubt that the discoveries which have shed so bright a lustre round the name of Black mark an epoch in the history of science, and gave a mighty impulse to human progress. A recent attempt to ignore the labours of Black and his great contemporaries, and to attribute the foundation of modern chemistry to Lavoisier alone, has already been amply refuted in an able inaugural address delivered a short time ago from the chair formally occupied by Black. The statements of Dr. Crum Brown may, indeed, be confirmed on the authority of Lavoisier himself. Through the kindness of Dr. Black's representatives, I have been permitted to examine his correspondence, which has been carefully preserved, and I have been so fortunate as to find in it three original letters from Lavoisier to Dr. Black. They were written in 1789 and 1790, and they appear to comprise the whole of the correspondence on the part of Lavoisier which passed between those distinguished men. Some extracts from these letters were published soon after Dr. Black's death by his friends Dr. Adam Ferguson and Dr. Robison; but the letters themselves, as far as I know, have never appeared in an entire form. I will crave permission to have them printed as an appendix to this address. Lavoisier, it will be seen, addresses Black as one whom he is accustomed to regard as his master, and whose discoveries had produced important revolutions in science. It may, indeed, be said with truth that Lavoisier completed the foundation on which the grand structure of modern chemistry has since arisen; but Black, Priestley, Scheele, and Cavendish were before Lavoisier, and their claims to a share in the great work are not inferior to those of the illustrious French chemist."

LETTERS FROM M. LAVOISIER TO DR. BLACK.

Paris, le 19 Septembre, 1789.

Monsieur,—C'est un membre de l'académie Royale des Sciences de Paris qui vous écrit à titre de Confrére: c'est un des plus zélés admirateurs de la profondeur de votre génie et des importantes révolutions que vos découvertes ont occasionnées dans les Sciences, qui profite, pour avoir l'honneur de vous écrire, de l'occasion de M. de Boullogne qui va finir son éducation à Edimbourg. Permettez-moi de vous le recommander. Il joint á d'heureuses dispositions un grand désir de s'instruire et il regarde comme un grand bonheur pour lui d'avoir une occasion pour se présenter à vous. Il a bien voulu, Monsieur, se charger de vous remettre un exemplaire d'un ouvrage que je viens de publier; vous y trouverez une partie des idées dont vous avez jetté le premier germe: si vous avez la bonté de donner quelques instants à sa lecture, vous y trouverez le développement d'un Doctrine nouvelle que je crois plus simple et plus d'accord avec les faits que celle du Phlogistique. Ce n'est au surplus qu'en tremblant que je le soumets au premier de mes juges et à celui dont j'ambitionnerais le plus le suffrage.—J'ai l'honneur d'être très-respectueusement, Monsieur, Votre très-humble et très-obéissant Serviteur,—LAVOISIER.

Paris, 24 Juillet, 1790

Monsieur,—J'apprends avec une joye inexprimable que vous voulez bien attacher quelque mérite aux idées qui j'ai professé le premier contre la doctrine du phlogistique. Plus confiant dans vos idées que dans les miennes propres, accoutumé à vous regarder comme mon maitre, j'étois en défiance contre moi-même tant que je me suis écarté sans votre aveu de la route que vous avez si glorieusement suivie. Votre approbation, Monsieur, dissipe mes inquiétudes et me donne un nouveau courage. Cette Lettre, Monsieur, vous sera remise par M. Terray intendant de Lyon neveu du Ministre des finances de ce même nom et mon parent; il conduit à Edimbourg son fils, jeune homme d'espérance et destiné a posséder une grande fortune, pour y finir son éducation et suivre les leçons des professeurs célèbres de l'université d'Edimbourg. Permettez-moi, Monsieur, de vous le recommander. L'intérêt que vous voudrez bien prendre à lui sera un premier titre qui l'annoncera d'une manière avantageuse et j'ai lieu de croire qu'il ne se rendra pas indigne de vos bontés. Je ne serai pas content jasque'à ce que les circonstances me permettent de vous aller porter moi-même le témoignage de mon admiration et de me ranger au nombre de vos disciples. La révolution qui s'opére en France devant naturellement rendre inutile une partie de ceux attachés à l'ancienne administration, il est possible que je jouisse de plus de liberté; et le premier usage que j'en ferai sera de voyager et de voyager surtout en Angleterre et à Edimbourg pour vous y voir, pour vous y entendre et profiter de vos lumières et de vos conseils. J'ai commencé un grand nombre d'ouvrages et de travaux et j'aspire à un Etat de tranquillité qui me permette d'y mettre la dernière main. J'ai l'honneur d'être très-respectueusement.—Monsieur, Votre très-humble et très-obéissant serviteur.—LAVOISIER, De l'académie des sciences.

Paris, le 19 Novembre, 1790.

M. Terray, Monsieur, m'a remis, en arrivant à Paris la lettre que vous m'avez fait l'honneur de m'écrire le 24 Octobre; il ne pouvait me faire un présent qui me fût plus agréable. J'ai cru que vous ne désapprouveriez pas que je la communiquasse à l'Académie des Sciences; elle n'a pas moins admiré l'élégance du style que la profondeur de philosophie et la candeur qui règne dans votre lettre, et elle a même désiré qu'elle fût déposée dans ses regis-

tres ; mais je n'y ai consenti, qu'à condition qu'il m'en sera t remis une copie certifiée du secrétaire. J'ai une autre grace à vous demander, mais sur laquelle je dois attendre votre aveu ; c'est de vouloir bien me permettre d'en publier la traduction dans les Annales de Chimie. M. Gillan a été témoin, depuis son séjour à Paris, de quelques expériences que j'ai faites sur la respiration et il a bien voulu y concourir. Nous nous sommes assurés des faites suivans.

1. La quantité d'air vital ou gaz oxigène qu'un homme en repos et à jeun consomme, ou plutot convertit en air fixe ou acide carbonique, pendant une heure est de 1200 pouces cubiques de France environ, quand il est placé dans une température de 26 degrés.

2. Cette quantité s'élève à 1400 pouces, dans les mêmes circonstances, si la personne est placée dans une température de 12 degrés seulement.

3. La quantité de gaz oxigène consommée, ou convertie en acide carbonique, augmente pendant le tems de la digestion et s'élève à 1800 ou 1900 pouces.

4. Par le mouvement et l'exercice on la porte jusqu'à 4000 pouces par heure et même davantage.

5. La chaleur animale est constamment la même, dans tous ces cas.

6. Les animaux peuvent vivre dans de l'air vital ou gaz oxigène, qui ne se renouvelle pas, aussi longtems que l'on le juge à propos, pourvu qu'on ait soin d'absorber, par de l'alcali caustique en liqueur, le gaz acide carbonique, à mesure qu'il se forme ; en sorte que ce gaz n'a pas besoin, comme on le croyait, pour être salubre et propre à la respiration d'être mélangé avec une certaine portion de gaz azote ou Mophete.

7. Les animaux ne paroissent pas souffrir dans un mélange de 15 parties de gaz azote et d'une partie de gaz oxigène, pourvu qu'on ait de même la précaution d'absorber le gaz acide carbonique, par le moyen de l'alcali caustique, à mesure qu'il est formé.

8. La consommation du gaz oxigène et sa conversion en acide carbonique est la même dans le gaz oxigène pur et dans le gaz oxigène mêlé de gaz azote, en sorte que la respiration n'est nullement accélérée en raison de la pureté de l'air.

9. Les animaux vivent assez longtems dans un mélange de deux parties de gaz inflammable et d'une de gaz oxigène.

10. Le gaz azote ne sert absolument à rien dans l'acte de la respiration et il ressort du poumon en même quantité et qualité qu'il y est entré.

11. Lorsque par l'exercice et le mouvement on augmente la consommation de gaz oxigène dans le poumon, la circulation s'accélère ; ce dont il est facile de s'assurer par le battement du poulx : et en général lorsque la personne respire sans se gêner, la quantité de gaz oxigène consommée est proportionnelle à l'augmentation du nombre des pulsations multiplié par le nombre des inspirations.

Il est bien juste, Monsieur, que vous soyez un des premiers informés des progrès qui se font dans une carrière que vous avez ouverte, et dans laquelle nous nous regardons tous comme vos disciples. Nous suivons les mêmes expériences, et j'aurai l'honneur de vous faire part de mes découvertes ultérieures. J'ai l'honneur d'être avec un respectueux attachement, Monsieur, votre très-humble et très-obéissant serviteur,—Lavoisier.

ASSIMILATION OF KREATINE BY PLANTS.

By CHARLES A. CAMERON, M.D., &c.

Wagner, in *Versuchs Stationer Organ*, xiii., 69 to 75, and 218 to 222, describes the results of his experiments with kreatine as a source of nitrogen for plants. Maize plants grew and developed seeds in a solution in which kreatine was the only nitrogenous substance present. The kreatine was absorbed unchanged, and was detected in the plants. Wagner refers to the fact that Hampe had found that urea is absorbed unaltered by plants. The same observation was made by me in 1857, and was reported in the *Transactions of the British Association* for that year, in the *Chemist* for November, 1858, and in the *Repertoire de Chemie, Pur et Appliquée*, Paris, December, 1858. I find that plants can absorb unchanged, and apparently derive nitrogen from, potassic nitrite, potassic cyanurate, and potassic ferrocyanide.

NOTICES OF BOOKS.

Inorganic Chemistry for Elementary Classes. By W. A. Shaith, M.A., Ph.D., F.C.S., F.E.J.S.

This little book contains in a concise form all that pupils require to know in order to pass the Examination of the Science and Art Department. So says the preface, and the description is strictly correct. Science teachers who wish to earn money in the May Examinations in Chemistry could not possibly pursue a more effectual course than to make their pupils get up the subject from this book. The first seven pages give definitions of Elements and Compounds ; Atoms and Molecules ; Absolute, Active, and Latent Atomicity ; Simple and Compound Radicals ; Acids, Bases, and Salts ; Oxacids, Hydracids, and Sulphacids ; Glyptic, Graphic, Symbolic, Empirical, Rational, and Constitutional Formulæ. Then follow a Glossary of Chemical Terms—the Laws of Boyle, Ampère, and Gay-Lussac, &c. ; a Table of the Elements classified into Perissads and Artiads ; a table, occupying thirteen pages, of constitutional formulæ ; and an explanation of graphical formulæ.

These subjects occupy two-thirds of the book ; the last third contains statements of chemical facts concerning hydrogen, chlorine, oxygen, boron, carbon, nitrogen, sulphur, and their compounds. Candidates who know this book off by heart will, we repeat, be almost sure of success at the Examination of the Science and Art Department. If, however, the object of the teacher be really to teach chemistry—and not merely to "pass" his pupils, the case is somewhat different, and Dr. Snaith's little book can hardly be recommended. Indeed, we can conceive no more effectual method of disgusting a pupil with the whole subject than to require him to commit to memory the definitions and formulæ which constitute the bulk of this book before entering on the study of the properties of the elements and their compounds.

It is, no doubt, important that the examiner for so influential an agency as the Science and Art Department should be one of the most eminent men in his profession, but it is clearly unfortunate for the interests of science when he is devoted to such a hobby as this system of graphical formulæ, and shows by his papers that a knowledge of the theories of the constitution of bodies is more highly regarded than a knowledge of the properties of those bodies. The existence of the book before us is a significant illustration of the working of the system of "payment on results" by which the Department seeks to assist science.

In 1870, £20,000 was paid by Government to science teachers. We venture to assert that if this sum were expended each year in founding a genuine school of science with efficient teachers, the benefit really rendered to science would be many times greater than that at present attained.

Still, for the object it proposes to secure, this little book is by no means badly compiled. It is cheap—is very well printed, and, in most cases, gives fairly good explanations.

Some of the definitions, however, are scarcely satisfactory, as the following quotations will show:—

Allotropic.—A *body* having different forms.

Deflagration.—The vivid *combustion* that is produced when the nitrates and some other salts are exposed to a red heat.

Precipitate.—The substance *dissolved* in a fluid which falls to the bottom on the addition of a reagent, and is left on the filter in the act of filtration.

Sublimation.—A process by which volatile bodies are *condensed by cold* into a solid form.

Carbonic Anhydride.—A colourless gas, with a slightly acid taste and *smell.*

On the Sanitary Improvement of Towns and the Utilisation of the Refuse. London: Waterlow and Sons, 1871.

This is a pamphlet illustrative of the Goux system of utilising and collecting the excreta of towns. The system, as applied to portions of the camp at Aldershot, has received very favourable reports; it has also been largely adopted at Halifax. The principle of the system consists in allowing the excreta to fall upon an absorbent material, which takes up the liquids and withdraws them from the action of the oxygen of the air. The absorbents employed are chaff, chopped or broken straw, damaged or refuse hay, coarse grasses, moor grass, dry street sweepings, dry horse-dung and litter, sweepings of markets, wool and hair, charcoal dust, dry fern, &c. Any or all of these are mixed in such proportion as may be most convenient, together with a small percentage of sulphate of iron or sulphate of lime. The receptacle may be a wooden tub, the sides and bottom being lined with the absorbent material. The system appears easily adaptable, the cost of conversion or fixing in the Borough of Halifax averaging from 7 to 35 shillings each house according to the style of fitting, &c. The system can also be employed in the case of receptacles of kitchen refuse. The agricultural value of the manure is said to be considerably above the average, while the dry nature of the contents of the tubs facilitates transport. The closets on this system are well adapted to factory purposes.

An Introduction to Practical Chemistry, including Analysis. By John E. Bowman, F.C.S., late Professor of Practical Chemistry in King's College, London. Edited by Charles L. Bloxam, F.C.S., Professor of Chemistry in King's College, London. Sixth Edition. London, J. and A. Churchill, 1871.

The author of this work selected for a prefatory note the celebrated quotation from Whewell's "Philosophy," "Facts are the materials of science, but all facts involve ideas. Since, in observing facts, we cannot exclude ideas, we must, for the purposes of science, take care that the ideas are clear and rigorously applied." This view has, indeed, been rigorously followed by both the author and the editor, and the result is a most comprehensive manual. This sixth edition presents many important additions. The entire course of qualitative analysis has been revised, and many of the examples in quantitative analysis are new, the weights employed being given in terms of the French as well as of the English standard. True to its title the work is essentially practical. It recommends itself to students by showing how chemistry may be thoroughly studied at a minimum of expense. The most practical chapter is, perhaps, that upon the methods of improvising reagents. Given the *primary* chemicals, as they are termed, or those indispensable to the analyst's cabinet, and consisting of sulphuric acid (vitriol), carbonate of soda (washing soda), chloride of sodium (common salt), nitrate of potash (saltpetre), sulphur (brimstone), ammonia (hartshorn), lime, biborate of soda (borax), ferrocyanide of potassium (prussiate of potash), carbonate or sulphate of baryta (heavy spar, barytes), sulphate of magnesia (Epsom salts), litmus (Archil); the work explains how, with such common materials as may be everywhere procured, all the reagents absolutely necessary for qualitative analysis can be improvised. For instance, acetate of lead may be prepared by leaving scraps of lead or shot in an open bottle partly covered with vinegar until the latter is distinctly sweet. The preparation of hydrochloric and nitric acids is in a similar manner left to the student, who thus acquires a far more practical knowledge of his subject than can ensue from the employment of purchased reagents. Not a less important chapter, in its way, is that detailing the blowing of the several minor glass vessels used in analysis. The author and editor have, in short, done their best to make the student independent by placing before him an epitome of their extended experience couched in the simplest language. Besides the qualitative and quantitative estimation of the most commonly occurring substances, there are included tables of the solubility of salts; the percentage of anhydrous acid in dilute sulphuric acid as estimated by specific gravity; similar tables for nitric and hydrochloric acids; for anhydrous potash in solutions of potash, soda, ammonia; absolute alcohol in dilute alcohol; and the specific gravities of mixtures of ether and alcohol in different proportions. The work is concluded with a glossary of chemical terms, and an alphabetical table showing the action of reagents on oxides and acids. The manual cannot be too strongly recommended to the notice of the student.

CORRESPONDENCE.

RELATION OF HEAT TO ELECTRICITY.

To the Editor of the Chemical News.

Sir,—In the absence of any information as to the internal resistance and electromotive force of the cells employed by Mr. Highton, it is difficult to hazard an explanation of his results. It seems probable, however, that the internal resistance of the iron-carbon cell was the greatest, and also its electromotive force, the latter owing, perhaps, to the polarisation of the platinum. Under these circumstances the zinc-platinum pair would give the greater current with the small resistance of the galvanometer, while, against the large resistance of the platinum wire, the conditions would be revested.

Mr. Highton must be aware that current-strength is dependent on resistance, yet he does not seem to have taken this at all into account. I venture to believe that if he will include the tangent galvanometer in the circuit, with such a length of platinum wire in each case as to reduce the current to the same amount, the temperatures will be sensibly equal. The *length* of wire heated is, of course, dependent not on the heating effect of a given current, but on the power of the cell to overcome resistance.

In conclusion I would suggest that it would give much more confidence in Mr. Highton's results, if before questioning laws which are the result of much patient and accurate investigation, he would make careful quantitative measurement of all the elements involved.—I am, &c.,

Henry R. Procter.

North Shields,
November 28, 1871.

EQUIVALENTS *VERSUS* ATOMS.

To the Editor of the Chemical News.

Sir,—I notice in the last number of the *Journal of the Chemical Society* that a great liberty has been taken with

a paper published by M. Berthelot, the well-known Professor of Organic Chemistry in Paris, inasmuch as the whole of the equivalent formulæ in this paper have been changed into the atomic notation, *which he never uses*. Now, as Berthelot, Henri St. Claire Deville, Boussingault, Fremy, Regnault, Cahours, and a considerable number of eminent chemists not only in France, but also in Germany, Switzerland, America, and even in England, *never use the atomic notation*, but adhere to the simpler method of equivalent formulæ, perhaps you will allow me to protest against the extraordinary custom of changing the formula used by any author in making abstracts of his papers.

It will be urged, perhaps, that it is done for the sake of uniformity, but in the *Bulletin* of the Chemical Society of Paris—the model journal—such an extraordinary liberty is never taken, though a more enthusiastic atomic chemist than M. Wurtz it would be difficult to find. But as a man of talent and experience M. Wurtz is aware that our science is in a state of rapid transition, and, perhaps, he feels that it is more than probable the atomic notation now in fashion with so many of the younger and less illustrious of organic chemists (who are constantly writing, but rarely making discoveries) will ere long cease to exist; nay, that a return to the old equivalent dualistic notation of Berzelius by them would not be without its advantages. However that may be, let them look up to M. Berthelot as their great model—let them rest assured that he sees further into chemical futurity than any of them do—and, above all, let them study his writings *in the original* if the "abstractors" of the Chemical Society's *Journal* are to mutilate and disfigure them as aforesaid.—I am, &c.,

EQUIVALENT.

Burlington House,
Dec. 4, 1871.

MISCELLANEOUS.

Smoke Drainage.—The Rev. B. W. Gibsone, M.A. B.Sc., has forwarded us a letter of his which appeared in the *Times* of Nov. 24. In it he asks "Why we should use chimney-stacks at all; one downward flue terminating in the water-drains would suffice to each house for the removal of its smoke." In reply to the objection—heated air will ascend and cannot be induced to descend without great external constraint—he says that if the drains of any district or block of houses are connected with a ventilating furnace having a lofty ornamental shaft, there would be at once obtained the motive current of air, and a means of destroying the noxious gases of our underground system, while the central furnace would supply warm air or water, or even gas, to all the contiguous dwellings, and the heavy fuliginous matters would be condensed chiefly in the sewers; the result would be—1. Absence of smoke in a city atmosphere. 2. Diminution of cost in construction of various chimney-stacks. 3. Absence of architectural disfigurements, such as zinc cowls and red cylindric pots. 4. Saving of fuel by total consumption of the smoke in the grate, the fire burning downwards instead of upwards. 5. Greater ease in cleansing the flue from soot, and in the removal of ashes. 6. Steadiness and irreversibility of air-draught, and power of thoroughly ventilating a room even when unfurnished with a fire. Mr. Gibsone's idea is not a novel one; the same idea occurred many years ago to Mr Spence, of Manchester, but the difficulty of getting sufficient draught was so great that it could not be carried out. A tower of an impracticable diameter would have to be erected, and the leakages into the sewers would be so numerous that, at a distance of 100 yards from the tower, no appreciable effect would be produced.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 16, 1871.

This number opens with the announcement of the death of Dr. Adolph Strecker, a well and deservedly known *savant* and scientific chemist, a member of this society, author of an excellent work on chemistry, and a constant contributor to the scientific periodicals of the German Empire. The deceased was Professor at Würzburg (Bavaria), and had just completed his fiftieth year.

This number contains the following original papers and memoirs:—

Formation of the Chrysanissic Acid and of an Acid Isomeric with it Belonging to the Meta Group.—H. Salkowsky.—While the formula of the chrysanissic acid was found by the author, in earlier researches on this subject to be—

$$C_6H_2\begin{cases}NH_2\\(NO_2)_2\\COOH\end{cases}$$

the origin of this acid, by the nitration of nitro-anissic acid, remained unexplained. The continued investigation of this subject has led to the discovery that the formation of chrysanissic acid is due to the presence of dinitro-anissic acid present in the crude product of the nitration of the nitro-anissic acid, the dinitro-anissic acid having been separated from that crude material, by treating it first with a very dilute solution of carbonic acid, and next precipitation by means of carbonate of soda and purifying with alcohol. The dinitro-anissic acid exhibits a crystalline mass, of a somewhat yellowish colour, insoluble in water, fusing at about 172°, and composed of—

$$C_6H_2(NO_2)_2.OCH_3.COOH.$$

Ammonia converts this acid into chrysanissic acid, while alkalies convert dinitro-anissic acid into that kind of dinitro-oxybenzoic acid which is derived from chrysanissic acid. This substance is, therefore, to be considered as dinitro-para-amidobenzoic acid, and the oxy-acid derived from it as dinitro-para-oxybenzoic acid.

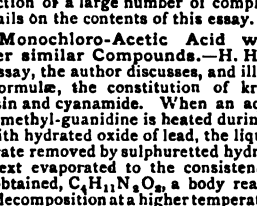
Contribution to our Knowledge of the Direct Formation of Aromatic Amido-Derivatives.—H. Salkowsky.—The contents of this paper partake of the nature of a preliminary notice, and bear upon the formation of some of the amido-derivatives of the aromatic series, viz., picramide, trinitro-aniline from trinitro-benzol, chloranilamide, and chloranilaminic acid from tetrachlorchinon. The author has extended the researches on this subject to those nitrated compounds of benzol which yet contain the remnants OCH_3 and OC_2H_5 of alcohol; thus picric acid ether, $C_6H_2(NO_2)_3.OC_2H_5$, and trinitro-anisol—

$$C_6H_2(NO_2)_3.OCH,$$

form, when treated with ammonia, picramide.

Composition of Minerals Containing Tantalum and Niobium.—C. Rammelsberg.—This paper contains an epitome of the author's extensive researches on this subject. We regret that, owing to the necessity of reproduction of a large number of complex formulæ, we cannot enter into details on the contents of this essay.

Behaviour of Monochloro-Acetic Acid with Methyl-Guanidin and other similar Compounds.—H. Huppert.—In the introduction to this essay, the author discusses, and illustrates with a series of complex formulæ, the constitution of kreatine, and its synthesis from sarkosin and cyanamide. When an aqueous solution of chloro-acetate of methyl-guanidine is heated during twelve hours to 120°, next boiled with hydrated oxide of lead, the liquid filtered, and the lead from the filtrate removed by sulphuretted hydrogen, the liquid again filtered, and next evaporated to the consistency of a syrup, a crystalline mass is obtained, $C_4H_{11}N_3O_2$, a body readily soluble in water, fusing without decomposition at a higher temperature, combining with acids, and the chlorhydrate forming, with platinic chloride, a double salt. This new body differs from kreatine by containing H_2O more. The constitutional formula of this substance, which is named glykolyl-methyl-guanidine is—



By the action of chloro-acetic acid upon morphine, the author obtained a crystalline compound, readily soluble in water, which appears to belong to the same class of substances.

The concluding pages of this number are devoted to an exhaustive biography of the late Dr. George Cajetan Kaiser, an eminent German *savant* widely known for his sound and extensive knowledge of technology and pharmacy as well as chemistry and mineralogy. The deceased was an excellent lecturer, and occupied for a series of years the Chair of Chemistry at the Lyceum at Landshut, Bavaria.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale, August, 1871.

This number opens with a very exhaustive memoir:—

Report on Leaden Pipes Coated Inside with a Thin but Continuous Layer of Block-Tin.—M. Tresca.—Although this subject does not belong to chemistry, we call attention to this memoir, which enters exhaustively into the particulars of an industry which is carried on in Paris by M. Hamon, who has succeeded in making the tubes alluded to by a greatly improved process, so that the thickness of the tin is reduced to ½ millim., while yet all the advantages of block-tin pipes are obtained. This memoir is illustrated by engravings.

This number does not contain any original papers on chemistry, but we notice the following essay:—

Cultivation of the Chinese Nettle (Urtica Nivea), Mode of Preparation of the Bark of this Plant, and Application of the Textile Fibres it Yields.—M. Ramon de la Sagra.

Les Mondes, November 30, 1871.

Hydrometre Clauzolles.—A brief description is given of a water-meter invented by the author just named, which instrument is stated to be the most perfect and accurate of its kind hitherto brought out, yet, at the same time, simple in action, and capable of working under very low as well as very high pressure without failing to give correct indications.

Description of a Newly-Invented Colorimeter.—M. Salleron.—Without the reproduction of the woodcut annexed to this paper it is not possible to enter into details on this instrument, but the results of the experiments made by the excellent Editor of this paper prove it to be very superior, as may be inferred from the following quotations (the quantities of the undermentioned substances refer to weight [grms.] in 1 litre of water, while the next following figure designates the the quantity of the substance first mentioned and detected by the instrument);—Caramel, 2·5, 0·0012; fuchsine, 0·01, 0·000007; aniline blue, 1·01, 0·000005; cochineal, 0·1, 0·0002; Prussian blue, 0·05, 0·00004; sap green, 0·2, 0·0006; gamboge, 0·2, 0·00006; logwood extract, 0·2, 0·00002; indigo, 0·02, 0·00002; tincture of litmus, 0·02, 0·00003.

Journal de Pharmacie et de Chimie, October, 1871.

This number contains the following original papers and memoirs:—

On Bromide of Potassium.—Dr. Falières.—A great portion of this memoir relates strictly to therapeutics, but, as regards the testing of the purity of bromide of potassium and its preparation more especially for medicinal purposes, the following suggestions are made:—1 grm. of bromide of potassium, previously pulverised, and put into a glass-stoppered bottle, is dissolved in from 30 to 40 grms. of distilled water. To this solution is added a solution of nitrate of silver, containing 1·427 grms. of that salt. When the precipitate has settled, there is added to the liquid, by means of a burette, a drop of a decinormal solution of nitrate of silver, which, if the bromide is pure, will not produce any further precipitate—the fact being that 1 grm. of the bromide requires precisely 1·427 grms. of nitrate of silver for precipitation, while 1 grm. of chloride of potassium requires 2·279 grms. of the argentic nitrate. It is clear, however, that the bromide will have to be tested for the absence of iodide, carbonate, and sulphate of potassium, and of nitrate of soda. As regards the preparation of bromide of potassium, the author proposes the following process:—100 grms. of bicarbonate of potassa are dissolved in 500 grms. of water; to this solution, 80 grms. of pure bromine are added, and, as soon as the effervescence ceases, there is also added a mixture of 90 parts of pure distilled water and 30 parts of liquid ammonia (sp. gr. = 0·875). The liquid is next evaporated to dryness, care being taken to apply a gentle heat as long as any vapours of carbonate of ammonia are given off. The residual saline mass is next ignited, so as to convert the bromate of potassa into bromide of potassium; the salt thus obtained is, after cooling, re-dissolved in pure distilled water, an aqueous solution of bromine added to this solution, which is next evaporated for crystallisation. By the addition of the ammonia, bromide of ammonium is first formed, and this salt, acting upon the undecomposed carbonate of potassa, converts it into bromide, while carbonate of ammonia is volatilised.

Preparation of Neutral Sulphate of Eserine.—A. Petit.—The hydro-alcoholic extract of Calabar beans is dissolved in water *q. s.* (1 part of the extract to 4 of water). This solution is filtered, and to it is, for every 20 grms. of extract, added 1 grm. of bicarbonate of potassa; there is next added an excess of ether, with which the liquor is thoroughly mixed, by shaking in a glass-stoppered bottle. The ether is gently decanted from the aqueous fluid, an operation best performed by a funnel, to the neck of which a tap is fitted. To the ethereal fluid, which contains eserine, is first added some distilled water, and next, drop by drop, dilute sulphuric acid (strength, 40 grms. of monohydrated sulphuric acid to 1 litre of distilled water), so that one drop = 0·05 grm. of acid, corresponds with the necessary quantity of eserine to form 0·01 grm. of neutral sulphate of eserine. The aqueous acid solution is next evaporated to dryness upon a water-bath, leaving the crystalline compound of sulphate of eserine.

Vienna Yeast.—Dr. Vigla.—This yeast is prepared in the following manner:—Previously-malted barley, maïs, and rye are ground up and mixed, next put into water at a temperature of from 65° to 75°; after a few hours, the saccharine liquid is decanted from the dregs, and the clear liquid brought into a state of fermentation, by the aid of some yeast. The fermentation becomes very strong, and, by the force of the carbonic acid which is evolved, the yeast globules (the size of which averages from 10 to 12 millims.) are carried to the surface of the liquid, and, forming a thick scum, that substance is removed by a skimmer, placed on cloth filters, drained, washed with a little distilled water, and next pressed into any desired shape by means of hydraulic pressure, and covered with a strong and stout tightly-woven canvas. This kind of yeast keeps for from eight to fourteen days according to the season, and is, both for bakers and brewers, very superior to that ordinarily used; the extra good qualities of Vienna beer and bread are partly due to the use made of this yeast in preparing these articles.

Annalen der Physik und Chemie, von Dr. J. C. Poggendorff, No. 9 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

On Electrolysis and Conductibility through Fluids.—G. Quincke.—An algebraico-physical essay.

On Apparatus and Methods of Observing for Crystallographico-Optical Researches.—P. Groth.—This memoir, illustrated by a series of engravings, is divided into the following sections:—Polarisation instrument; the stauroscope; apparatus for determining the axial angles; goniometer.

Intrinsic Nature of Gases.—G. Hansemann.—An algebraico-physical essay; an observation also bearing upon the following paper:—

Influence of Astronomic Motion on Optical Phenomena.—E. Ketteler.

On Anomalous Dispersion, viz., of Rays of Light.—A. Kundt.—The third portion of an optical essay, illustrated by several engravings.

Method of Filling Barometer Tubes without the Necessity of Boiling the Mercury and without the Danger of Breaking the Tube.—H. Wild.—The author describes at length, and illustrates by engravings, an ingenious method of filling barometer tubes; while the second part of the paper refers to the purifying of mercury. Take 1000 grms. of that metal, pour it into a strong flask capable of holding 2000 grms. of waters. Take, next, 30 grms. of a solution of chloride of iron (made up of 1 part of the dry salt and 3 parts of water), add this to the mercury, and, after having closed the flask with a cork, shake it vigorously until the metal is so finely divided that with the naked eye no more globules can be seen. Water is next poured into the flask, and the contents, having been well agitated, are left for a moment to settle, and the impure solution poured off; this operation is repeated twice, after which the greyish mass of very finely divided metal is poured into a porcelain basin, which, having been placed on a water-bath, is made dry, and next brought to its normal state of aggregation by rubbing in a glazed porcelain mortar. The metal is next filtered through good tough writing-paper wherein a perforation has been made with a needle.

Contribution to Micro-Mineralogy.—Dr. A. von Lasaulx.—A paper illustrated by a series of engravings exhibiting magnified figures of crystals.

Sitzungsberichte der Mathematisch-Physikalischen Classe der Königlich Bayerischen Akademie der Wissenschaften zu München, vol. ii., 1871.

The original papers and essays relating to chemistry published in this volume are the following:—

Fat Contained in Beer-Yeast.—Dr. Vogel.—After referring first to the fact that all cereals contain a larger or smaller quantity of fatty matter, which is an essential constituent of the grain, the author describes at length his experiments made for the purpose of extracting, by means of ether, the fat contained in beer-yeast, an oil boiling at about 200°; sp. gr. = 0·901; decomposed when heated above 300°, and yielding acrolein. The quantity of this oil found in 1 litre of the yeast amounts to from 0·2 to 0·3 grms. It appears that this oil is in most respects akin to the fatty matter found in barley. The greater part of the contents of this paper bears particularly on zymotechny.

Fossil Resin which perhaps Belongs to the Flora of the Amber.—H. Spirgatis.—The author obtained a specimen of a kind of soft substance, occasionally found along with amber in that portion of the Baltic (situated near the coast of East Prussia) where dredging for amber is regularly carried on. This soft material is vulgarly known as unripe amber, a soft semi-elastic substance, which hardens gradually by exposure to air; sp. gr. = 0·934; insoluble in caustic alkalies, oil of turpentine, alcohol, and also insoluble in chloroform, sulphide of carbon, and petroleum, which have the effect, however, of softening this substance and making it swell; benzol only dissolves out a small portion of an essential oil, while ether, in addition to the latter, also dissolves some of the resin, which was found on analysis to consist, in

100 parts, of:—Carbon, 86·02; hydrogen, 10·93; oxygen, 3·05; formula, $C_{40}H_{62}O$. The author observes that the composition of this resin is very different from that of amber (which contains, after deducting ash, in 100 parts, according to Schrötter:—Carbon, 78·60; hydrogen, 10·19; the rest being O), while the composition of this resin is more like that of the fossil resin of Settling-Stones, which, according to the late Professor Johnston, contains, in 100 parts:—Carbon, 85·25; hydrogen, 11·03.

On Rammelsbergite.—F. Sandberger.—This rather rare mineral, also known as Weissnickelkies, was found to have a sp. gr. = 7·19, and consists, in 100 parts, of:—Arsenic, 63·30; nickel, 26·65; iron, 2·06; bismuth, 2·662; with traces of copper, cobalt, and sulphur.

Influence of the Germination Process on the Fat Contained in the Seeds.—Dr. Vogel.—From the contents of this essay it appears that, by the process of germination, the quantity of fat contained in seeds decreases in the ratio of from 0·094 to 0·320 per cent; average, 0·156 per cent.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, November 23, 1871.

This number contains the following original matter:—

Notice on Glue, Cements, Lutes, &c., in Reference to their Mode of Application.—Dr. Sibon.—The contents of this paper are chiefly of interest to those whose daily vocation is the use of cements for the purpose either of mending glass, china, small articles made of wood, horn, &c., or the use of the materials alluded to in the construction, for instance, of physical instruments wherein it is required to unite glass and metals together.

Description of a New Telegraphic Instrument.—M. Chambrier.

Magneto-Electric Explosion Apparatus.—J. Breguet.—Illustrated by a woodcut. A very ingeniously-devised instrument constructed for the explosion of gunpowder, dynamite, nitro-glycerine, and gun-cotton, in mines, quarries, and also in warlike operations.

Resistance Offered by Air Against the Motion of an Air-Balloon.—H. Mangon and D. Claye.—A mechanico-physical paper, recording the results of some experiments made at the Orléans railway-station with two air-balloons, respectively of 6 and of 10·75 metres diameter.

NOTES AND QUERIES.

Naphthalic Acid.—Will some reader please tell me the readiest way to make naphthalic acid?—NAPHTHALINE.

Comparative Tables of Hydrometers.—Can any of your readers inform me where I can procure a good book or journal giving the comparative tables of Twaddell's hydrometer with that of Baumé.—L. C.

Spence's Process of Treating Mineral Phosphates in the Manufacture of Artificial Manure.—I shall be glad if some of your readers will give more details of this process than are contained in your brief report of Dr. Wallace's Address at the Glasgow Philosophical Society, on Monday, Nov. 6.—W. L.

Apparatus for the Liquefaction of Gases.—I should feel obliged if any of your correspondents would give, or refer me to, a good detailed description of the valve to the receiver in Natterer's apparatus for the liquefaction of gases. There is a description in Ganot's "Physics," p. 260, but it is too general for my purpose.—S. T.

Gas-Proof Fabric.—Can any of your numerous readers inform me, through the medium of your "Notes and Queries," how I can make linen or cotton fabric gas-proof? I have made a large gas-bag of cotton cloth, and want an oil-varnish of some sort that will render it as impervious to gas as oiled silk is. India-rubber varnish will not do, as it is liable to become soft and adhesive after a time if moisture come in contact with it.—L.R.C.P. Edin.

Adulterations in Food and Drink.—Can any of your correspondents tell me if there is any book or books which give simple but trustworthy directions for detecting adulteration in food and drink? The processes given by Hassall and Normandy are long and complicated, and often imperfect. The food analysts appointed by various towns and counties must have some such processes, as they are required by the Act of Parliament to complete their analyses in a very short time.—AN AMATEUR CHEMIST.

Test for Starch.—I do not know if it has escaped the notice of chemists that iodine is not a test for starch in solutions of sugar, brewer's wort, albumen, &c. It is customary with some brewers to test their wort for starch, which, though very likely to be present, they never find. I have added starch to wort before testing with iodine, and you may guess my surprise on applying the test at not having the usual reaction. The starch was not at once converted, for on the application of a stiff dose of SO_2 I had the starch reaction. My solutions were cold and acid.—ALFRED TERRY.

Coagulation of Clay.—(Reply to X. Y. Z.).—Chloride of iron and carbonate of soda, in the proportion of 32 kilos. of the former salt and 84·5 of the latter to a quantity of water equal to 1000 cubic metres, has been found a most valuable and quite innocuous means of purifying water, even such as is otherwise quite unfit for drinking purposes and could not be rendered so by alum. The salts alluded to are best previously dissolved in some pure water, and the solutions, that of iron first, poured into the tank containing the water intended to be operated upon. The soda solution is not added until after a few moments, the water being first vigorously stirred. The soda solution having been added, the fluid is stirred again, and then left quiet for the purpose of allowing the very bulky and flocculent sediment to deposit; this takes considerable time—from twenty-four to thirty-six hours. The *strychnos potatorum* is used in India for purifying clayey water.

The Milanese Sewerage System.—This is recommended by Mr. Child, of Oxford, as being suitable for small towns and country villages. Its essential feature is the drainage of the houses into water-tight cesspools, which are emptied frequently, efficiently, and quite inoffensively by means of a barrel-cart, previously exhausted of air, and a hose. The barrel-cart then conveys the sewage to a depot at a convenient distance, where all that is saleable is sold to farmers, and the rest is manufactured into a kind of dry artificial guano. Many of our little towns and villages lie on dead flats or at the bottom of deep valleys, where ordinary sewerage works could not be established without an expensive provision for raising the sewage in order to render it available for irrigation. In such places the Milanese system might be carried out with ease and at comparatively small outlay. A certain number of cesspools must be rendered water-tight—a process not very expensive. One cesspool would serve for several cottages, and frequent emptying would be better than large size. Two Milanese barrel-carts must be procured, and these, with a small steam-engine at the depot to work the air-pump, would, together with about three men and two horses, form the whole of the apparatus required for testing the system upon a small but sufficient scale. On the day on which Mr. Child visited the depot near Milan, farmers' carts were waiting there literally in scores to obtain their supply of it, and he feels sure that if landed proprietors or farmers were to give the system a trial in this country they would find it well worth adoption.—*The Garden*.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 11th.—London Institution, 4. Prof. Huxley, LL.D. F.R.S., on "Elementary Physiology."
—— Medical, 8.
—— Royal Geographical, 8.30.
TUESDAY, 12th.—Civil Engineers, 8.
—— Photographic, 8.
WEDNESDAY, 13th.—Society of Arts, 8.
THURSDAY, 14th.—Royal, 8.30.
—— Royal Society Club, 6.

TO CORRESPONDENTS.

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ERRATUM.—Vol. xxiv., p. 156, line 32 from top, *for* "2 atoms of nitrogen" *read* "4 atoms of nitrogen."

G. H. B.—Watts's "Dictionary of Chemistry."

A. T. Jones, Bilbao.—A work containing the information you require is in the press; it will be duly announced in our columns.

BOOKS RECEIVED.

Elementary Treatise on Physics, Experimental and Applied, for the Use of Colleges and Schools. Translated and Edited from Ganot's Elements de Physique. By E. Atkinson, Ph.D., F.C.S. London; Longmans, Green, and Co.

New Remedies; a Quarterly Retrospect of Therapeutics, Pharmacy, and Allied Subjects. By Horatia C. W. Wood, jun., M.D. New York: William Wood and Co.

The Journal of the Iron and Steel Institute, vol. ii. London; E. and F. N. Spon, Charing-Cross.

Tobacco; an Essay. By Henry Gibbons, M.D. London; James Burns.

Asiatic Cholera in Bristol in 1866. By William Budd, M.D., F.R.S. Bristol: T. Kerslake and Co.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 629.

ON THE

CHEMICAL CONSTITUTION OF GLYCOLIC ALCOHOL AND ITS HETEROLOGUES,

AS VIEWED IN THE NEW LIGHT OF THE "TYPO-NUCLEUS" THEORY.*

By OTTO RICHTER, Ph.D.

THE common saying, that "a tree is known by its fruits," applies with equal force to scientific pursuits, no matter whether these pursuits are carried on in the practical or in the theoretical department of human knowledge. The art and science of chemistry, from being a plain and simple record of systematically arranged facts, is now fast approaching that period of its development when, as a rational science, it will gain for itself a position fully as noble and imposing as that of astronomy, mechanics, optics, and other branches of applied mathematics. In pondering the various questions and problems which require to be solved before we can hope to attain this most desirable object, I was not slow in discovering that the garden of science enclosed within its precints one of those rare and precious trees which, under judicious culture, might be made to furnish a plentiful crop of novel and original conceptions. It is now more than twenty years since I bethought myself of investigating the singular configuration and structure of that wonderful tree, as well as the internal organisation of its multifarious and matchless productions. Considering that it is imperative upon me to approach my subject in a spirit of the utmost fairness and candour, I feel it my duty to inform you that at no great distance from my own favourite tree of chemical knowledge there stands another and much older tree of chemical knowledge, which has for a considerable period enjoyed the privilege, or I should rather call it the monopoly, of supplying the chemical market with its bright and showy, but, upon the whole, spurious and unpalatable, productions.

The two trees of chemical knowledge above alluded to are in reality two different chemical theories, which, with many connecting links and points of resemblance between them, are nevertheless in their leading doctrines and principles vitally opposed to one another. The younger of these theories, which may appropriately be designated the "typo-nucleus" theory, is the offspring of my private meditations. Its general tenets and principles were first promulgated by me at the meeting of the British Association in Norwich in the year 1868, and a small pamphlet, entitled "General Outline of an Original System of Chemical Philosophy, comprising a determination of the Volume-Equivalents, as also a New Theory of the Specific Volumes of Liquid and Solid Substances," soon afterwards appeared in print, and was made known by means of advertisements. The older of these two theories, which may appropriately be designated the "typo-radical" theory, is, I scarcely need to tell you, the dominant and all but universally adopted system of our modern chemical schools and laboratories.

It is with the sincere and anxious desire of furthering the cause of scientific progress, which the founders of this world-famed Institution have chosen for their motto, that I have sought and obtained the kind permission of your Committee to lay before you a variety of experimental evidence in support of the validity of my assertions, which, if it does not convince you on the spot, will at least, I flatter myself, set you to ponder and ruminate. The subject of my present discourse, by the aid of which I hope to illustrate a few of the many salient points which distinguish the "typo-nucleus" theory from its full-grown and powerful rival, bears for its title "The Chemical Constitution of Glycolic Alcohol and its Heterologues, as viewed in the new light of the 'Typo-nucleus' theory." But in order to enable you more fully to comprehend the scientific bearing and significance of these novel conceptions and doctrines, it is requisite that I should first of all explain to you the precise meaning of the compound terms "typo-nucleus" and "typo-radical." As regards the first of these components you may perhaps imagine that the word "typo" expresses one and the same idea in both theories. Let me at once disabuse you of this mistake. In my chemical system the seven principal types enumerated therein represent as many distinct and separate forms of molecular arrangement, and it is of importance to add that each one of these types embraces and characterises one single order of chemical compounds, and this order exclusively. In the "typo-radical" system, on the other hand, the word "typo" bears an essential different meaning, for it implies that, in accordance with the general law of substitution, chemical compounds may be systematically distributed over a few simple patterns, models, or types. The so-called rational formulæ employed for these types are meant to convey to the mind a more or less clear and definite idea of the relative position of the component elements, and likewise of their leading chemical properties and functions. The substances, whose chemical formulæ have been employed, or, I should rather say, "perverted" for this purpose are hydrogen, water, ammonia, chloride of ammonium, carbon, and marsh-gas. As regards the second of these compounds, namely, the expressions "nucleus" and "radical," a few remarks will suffice for determining the precise meaning of these critical and portentous epithets. Observe, then, first of all, that the two types of the simple hydrocarbon molecules and of the simple normal acid molecules are regarded in my system as the first self-supporting productions of the chemical forces, and that the various species of elementary molecules are all supposed to belong to the class of non-enveloped acid nuclei, and it is under this latter form that they occupy the first place in the series of normal acid molecules, and that like the rest of these members, they are believed to possess the power of uniting with the bases. The nuclei of the normal acids are further supposed to occur not singly, but always in pairs, in other words, as twin nuclei, and it is one of the distinguishing characteristics of their component nuclei that they cannot be represented by more than one bivalent molecule. You will, moreover, bear in mind that the other members of the acid series are produced from these twin nuclei by the successive intromission of one or two chemically similar elementary molecules into that particular region of the atomic edifice to which, from its contiguity to the nucleus compartment the term "envelope" has perhaps not unfitly been applied. The expression "radical" is commonly understood to refer to that section of a given atomic system which in the various chemical processes is observed to remain either totally unaltered, or to become modified in such a manner that, for every component molecule of one kind which is taken away, an equivalent molecule of another kind is supposed to step into its place so as to fill up the vacancy. Unfortunately this definition of the word "radical" holds good under the above restrictions only, and necessitates the exchange of one radical for another as often as the result of the experiment testifies to the fact that the loss of constituents in the radical has not been compensated by the accession of new elements. It is, therefore, not to be wondered at if this tendency to fluctuation in what ought to be the most stable and enduring portion of the atomic edifice continues to prove a source of serious trouble and embarrassment to the devisers and advocates of the typo-radical theory.

* Abstract of a Paper read before the British Association, Edinburgh Meeting, 1871.

In the language of one set of interpreters the atoms are said to be furnished with a variable number of movable poles or points of attraction, which they are able to turn in every direction, nay, if needful, even the one against the other; while in the language of a different set of interpreters, mere units of affinity are talked of and employed in their calculations. It is further alleged that the saturating capacity of the elementary molecules is exactly commensurate to the number of poles or units of affinity thus stored up within them. I, for my part, must confess that I cannot reconcile myself to either of these modes of interpretation, and more especially not to that grotesque and ludicrous exhibition of capers and summersaults which these *soi-disant* poles are made to perform within the walls of their globular dwelling. Let us now suppose that some of my hearers, impressed with the awkwardness of the situation, put this question to me: What would you advise us to do in order to extricate theoretical chemistry from its present unbecoming and ungraceful attitude? To this question I can return a ready and straightforward answer, and I will give it in the language of a musician who knows that in the strict style of contrapunctal writing, every discord ought to be duly prepared and resolved, and every licence avoided in order to produce in all the parts an agreeable and harmonious effusion of musical sounds. I boldly declare and maintain before this meeting that when this very ingenious and plausible, but philosophically untenable, polar hypothesis was, as it were, by way of licence, and without due preparation, brought to bear upon Gay-Lussac's famous law, that aëriform elementary substances are capable of combining, in certain simple ratios of their specific volumes, a grave and fatal error was committed by our chemical guides and advisers. I must, therefore, strenuously protest against any further attempts of screening and propagating this error, which has been productive of incalculable mischief, inasmuch as it has laid the foundation for that narrow, hasty, and superficial style of arguing which our modern theorists, in their eagerness to establish rational formulæ, have thought proper to cultivate—a style which, in its wild and precipitous efforts to tear asunder in these formulæ, and to dislocate what, by Nature herself, is and ought to remain united, finds no parallel in the whole wide domain of natural philosophy. What, then, I ask in sober earnest, are the boasted advantages, which have accrued to theoretical chemistry from this incessant hunting and racing after multivalences and atomicities? I, for my part, can see none, and I must, therefore, denounce the whole movement, which is now in full swing, and which appears to be headed and fomented by a few highly-gifted, but rather overweening intellects, as being in reality a movement in a circle which, if persisted in, will simply land you at the same point from which you were starting some years ago, on what I cannot help stigmatising as a "wild goose chase," after the self-begotten phantoms of your own over-heated imagination. Thus, then, it has come to pass that the main problem of modern chemistry, the satisfactory solution of which will not fail to inaugurate a new era of scientific progress, has been utterly ignored and lost sight of. This problem may be stated as follows:—What is the truest, safest, and most trustworthy test and criterion for discriminating between the essential and the non-essential constituents of complex molecules, as well as for distinguishing between the various modes and forms of chemical union, whereby the essential constituents are cemented to each other and typically grouped together in conformity with the general law of chemical rank-order, representing, so to speak, the very bone and marrow of the molecular organism, while the non-essential constituents, from their greater mobility and readiness to dissociate themselves from that organism, are evidently connected with the former by much looser and more fragile ties of chemical affinity? And here I take the liberty of reading my translation from the German, of what may be considered a sort of public confession of the chemical creed and convictions entertained by one of our most eminent continental chemists and philosophers. Professor Kolbe, of Leipzig, says in one of his numerous essays—I allude to the paper where he dilates on the derivatives of cyanamide:—"I have gained my point," says the learned Professor, "if I can succeed in convincing the reader how far those chemists have gone astray from the path of truth who flatter themselves that they have actually solved the problem of the chemical constitution of substances after they have managed to link together in due form and order all the elementary constituents of a given compound, but who fail to perceive that every group or constellation of atoms requires a ruling head or principal, around which the other members are destined to occupy a more or less subordinate position. The cause of this oversight is the erroneous impression, or, I should rather call it, the fashionable delusion that chemical combinations are comparable to sets of chains, open or closed, as the case may be, and whose component links are all equal in point of rank and superiority. I, for my part, would rather prefer likening these combinations to a regularly organised community, say, for instance, to a regiment of soldiers, which is composed of a colonel, subalterns, and commoners, In such a regiment the common soldiers are lower in rank than the lieutenants and captains, while the colonel is the highest in command, and every one must obey his orders." These, gentlemen, are the clearly expressed views and sentiments of one of our most intelligent and distinguished chemists, and I myself for one am ready to acknowledge their general veracity and correctness. But I must go one step farther by saying that although there is a strong resemblance between my acid twin nucleus with its subordinate adjuncts, and the commander of a regiment with its staff of adjutant officers, there is this vast and vital difference between us, that I have shaken myself entirely free from the shackels and trammels of the dominant school philosophy, while our esteemed colleague, who in his own person happens to be a mighty leader and spokesman on the typo-radical side, must be supposed to be still deeply enamoured of his long-courted and idolised mistress. After these rather lengthy but unavoidable preliminaries, I shall now do myself the honour of discussing before you the main subject of this paper, which bears for its title, "The Chemical Constitution of Glycolic Alcohol and its Heterologues, as viewed in the new light of the typo-nucleus theory."

(To be continued).

ON THE

IRIDIUM COMPOUNDS ANALOGOUS TO THE ETHYLEN AND PROTOCHLORIDE OF PLATINUM SALTS.*

By Professor SAMUEL P. SADTLER, Ph.D.,
Pennsylvania College, Gettysburg, Pa.

Among the compounds which we are accustomed to call *organo-metallic*, those of $PtCl_4$ and $PtCl_2$ play, perhaps, the most important part. We can separate them, however, into the two great classes—those where the $PtCl_4$ and $PtCl_2$ enter by substitution into compound ammonia atoms, and thus form bases more or less complex, but having still a certain connection; and those where the $PtCl_4$ and $PtCl_2$ take up organic radicals of different degrees of valence to form saturated compounds.

The range of this last class, as can be seen, is very wide; one of the most prominent of these compounds, however, and one which exercised for some time a very

* Extract from an Inaugural Dissertation at the Univ. of Göttingen, April, 1871.

considerable influence upon the theoretical views held at that time, is the compound of $PtCl_2$, known as Zeise's salt, and discovered and investigated by him in 1830.

It is not necessary to recount here the controversy which took place between Zeise and Liebig on the subject. Suffice it to say that, by subsequent investigations of Griess and Martius and of Birnbaum, its formula is definitely settled as $PtCl_4,C_2H_4+KCl$.

The investigation I now undertook was to see if a similar base of iridium could be prepared. Various considerations, stated at length in my original paper, led me to believe that iridium might not combine exactly as platinum did in the formation of these salts.

After obtaining the double chloride of iridium and ammonium in the usual way, by decomposing the osm-iridium, I made some tests as to the manner of formation of the salt. An attempt to form it by taking the double chloride of iridium and ammonium in solution, and, passing a stream of chlorine through to break up the chloride of ammonium, to then conduct ethylen gas into it, was unsuccessful. The method which succeeded most perfectly was to act upon iridium chloride. This was obtained by igniting the double chloride of iridium and ammonium, thus obtaining iridium oxide and metallic iridium, which was then heated with aqua regia in sealed tubes of Bohemian glass to 180° or 200° C. This solution of $IrCl_4$ I then treated with absolute alcohol. On adding KCl, and allowing it to crystallise out, I got the greenish-brown crystals of the iridium-ethylen base. On subjecting them to an organic combustion, I obtained as products carbonic acid and water. They burned with a luminous flame, and answered, in short, all the tests applied to Zeise's platinum salt.

Another experiment, to see if ethylen gas would act directly upon the $IrCl_4$, reducing it and uniting at the same time, was unsuccessful.

It will thus be seen, that the only method of preparing the iridium-base is by the reducing action of alcohol on iridium chloride, according to the reaction:—

$$\underbrace{IrCl_2\ Cl_2+\begin{matrix}CH_3\\|\\CH_2OH\end{matrix}}_{}+\begin{vmatrix}CH_2H\\|\\CH_2OH\end{vmatrix}$$

$$=IrCl_2,C_2H_4+2HCl+\begin{matrix}CH_3\\|\\COH\end{matrix}+H_2O,$$

the products of which are iridium-ethylen-protochloride, hydrochloric acid, aldehyde, and water.

The purifying of the necessary iridium was found to be a very long and tedious operation, the last traces of platinum sticking very pertinaciously to the iridium salt. The processes in use also leave much to be desired in the way of completeness and expedition.

The method selected for separation was the method of Birnbaum, grounded upon the distinct and separate crystallisation of the double cyanides of iridium and barium, and platinum and barium. To convert the double chlorides of iridium and ammonium, and platinum and ammonium, into the double cyanides of iridium and potassium, and platinum and potassium, after trying Wöhler's and Muckle's method and obtaining unsatisfactory results, I had recourse to Martius's method. This consists in mixing the dry impure chloride of iridium and ammonium with powdered cyanide of potassium, and fusing and then taking up with water the fused mass. After working some time with this method, with rather poor results, owing to the high heat required to bring the mass to fusion and the invariable decomposition of the newly formed double cyanides, resulting from the application of such a heat, I modified the method in several particulars. I found, on trying, that the black iridium oxide went very readily into solution in the fused cyanide of potassium. Taking, therefore, the double chloride of iridium and ammonium and igniting it to transform it into the iridium oxide, I proceeded after the following manner:—

Covering the bottom of the crucible with a bed of powdered KCy, I then added a mixture of KCy and iridium oxide, and exposed it to the flame of the blast-lamp. The fusing cyanide takes up quite readily the metallic oxide, and is soon in calm fusion. A reduction still takes place, but by no means to the extent experienced before. This is occasioned by the strong heat which has to be applied to get the mass into full fusion. Another modification which I then made has some advantages over this just described. It is to bring a few pieces of KCy to full fusion, and then keeping it so, to add a previously prepared mixture of the iridium oxide and finely pulverised cyanide of potassium to it, in small quantities at a time. The advantage here is, that, when the KCy has once been brought to fusion, it can be kept there with a comparatively small flame, and the reduction of the double cyanides does not occur so readily. It is true, that adding the iridium so slowly, the compound is kept in the fused state longer. My experience, however, leads me to prefer this latter plan, and I generally used it as giving the largest yield. Birnbaum's method proper is now used. The solution of the double cyanides, filtered off from any unattacked iridium oxide, contains a tolerably large excess of free KCy. This is destroyed by adding dilute HCl. When neutral, a concentrated solution of copper vitriol is added. The violet-coloured precipitate of mixed double cyanides of iridium and platinum with copper is washed by decantation with boiling water. While suspended therein, a strong solution of caustic baryta is added. The copper is thrown down as brown oxide of copper, and the double cyanides of iridium and platinum with barium are formed, which remain in solution. When the fluid reacts distinctly alkaline, after a minute or so boiling, it is filtered off, and then CO_2 is passed through, until a neutral reaction is obtained. Filter off the precipitate of $BaCO_3$, and then concentrate for crystallisation. The yellow platinum salt crystallises out first in small crystals, with a play of colours from yellow to blue, being similar in their dichroic effects to most of the other double cyanides of platinum. The iridium salt crystallises then in larger colourless prisms, which can be easily separated mechanically from the platinum crystals. The iridium crystals I ignited in a porcelain crucible, and having thus completely broken up the compound, drew out the baryta with boiling water. The iridium, after being well washed and ignited to completely oxidise it, was heated as before with aqua regia in a sealed tube to 200° C. The $IrCl_4$ solution obtained was again treated with absolute alcohol, and, on addition of KCl and NH_4Cl, the crystallised salts were obtained.

However, the compounds which were now formed were, contrary to my expectations, not the ethylen salts pure and alone, but there was a simultaneous formation of what appear to be several distinct compounds. Although in one preparation of ammonium salt analysed, the ethylen-protochloride-salt was isolated tolerably pure, yet, in the majority of the analyses, I had to do with a mixture difficult to separate even under the lens. The readiness with which these compounds decompose when subjected to re-crystallisation, even although one observes the precaution of keeping the solution distinctly acid, prevents any successful purifying that way. The preparation, therefore, had to be prepared for analysis by drying between bibulous paper, and then over H_2SO_4 or at 100°, according as I wished to determine the percentage of water or not. A certain amount of HCl from the acid solutions, therefore, adhering to the crystals, made the Cl determinations as a rule high. Still the results approximate sufficiently, these circumstances being taken into consideration, to the formulæ given, to show that several distinct compounds are here formed. My first crystallisation consisted of brownish-red octahedra, which when analysed gave in three Cl determinations 42·13 per cent, 42·07 per cent, and 42·09 per cent Cl, showing them

to be simple $IrCl_4(KCl)_2$, of which the percentage of Cl is 42·08 per cent.

I next got a crystallisation of fine sharply-formed monoclinic crystals of a reddish-brown colour, which I think the analyses, although not perfectly conclusive, still go to show to be a new compound. Several different crystallisations of it were analysed. It could not always be entirely separated from the slight crust of decomposed KCl which separated out along with and among the crystals.

Preparation No. 1.—Large well-formed crystals, with but very little foreign matter adhering to the sides.

0·1567 grm. dried over H_2SO_4 lost by heating to 100° 0·0170 grm. = 10·85 per cent:
gave 0·0525 grm. metallic iridium = 33·50 per cent:
gave also 0·2275 grm. AgCl = 0·0563 grm. Cl = 35·92 per cent.

0·1610 grm. dried over H_2SO_4 lost by heating to 100° 0·0172 grm. = 10·68 per cent:
gave — Ir determination accidentally spoiled:
gave also 0·2320 grm. AgCl = 0.0574 grm. Cl = 35·65 per cent.

This we see at once cannot be any chloride of iridium and potassium. Its luminous flame, too, when burned, shows the same. Nor do the percentages agree with the simple potassic-ethylen iridium protochloride—

$$IrCl_2C_2H_4KCl+2H_2O,$$

where the Ir = 48·45 per cent and Cl = 26·19 per cent.

If we reckon out the ratio of iridium to chlorine, we find it as 1 : 6, showing it to be an iridium chloride compound. The large per cent of loss on heating, the small Ir. and Cl per cents, when compared with double iridium and potassic chloride, and the luminous flame when burned, all go to show that an organic constituent must make the additional per cent. If we suppose now ethylen to enter here into the union with iridium chloride, hanging itself on, we can expect from the consideration of analogous compounds that 2 atoms of the bivalent radical C_2H_4 would join the atom $PtCl_4$.

We would have on this supposition the formula

$$IrCl_4(C_2H_4)_2(KCl)_2+\chi H_2O.$$

Now this formula with 3 atoms H_2O gives Ir = 32·93 per cent, Cl = 35·61 per cent, and with 2 atoms H_2O, Ir = 33·95 per cent, Cl = 36·71 per cent; anhydrous it gives Ir = 36·20 per cent and Cl = 39·14 per cent.

The large per cent of loss at 100° is not accounted for by $3H_2O$, which give only 9·03 per cent; but it is possible that in a compound where the organic constituent is so loosely connected with the rest, as must be the case here, a partial decomposition of the salt enters at 100° already.

In another preparation, also well crystallised, 0·1822 grm. dried at 100°:
gave 0·0678 grm. metallic iridium = 37·21 per cent;
gave also 0·3063 grm. AgCl = 0·0758 grm. Cl = 41·59 per cent.

In another preparation, indistinctly crystallised, 0·0502 grm. dried at 100°:
gave 0·0172 grm. metallic iridium = 34·26 per cent.
(Probably low from HCl mechanically admixed.)

In another preparation, also indistinctly crystallised, 0·3207 grm. dried at 100°:
gave 0·2125 grm. AgCl = 0·1268 grm. Cl = 39·53 per cent.

It will thus be seen the determinations, all things considered, agree close enough with the theoretical per cents of the formula to make it very probable. The want of enough sufficiently-well crystallised material prevented me from making an organic combustion which might settle it definitely.

Several individual crystals of the first crystallisation were very sharply and clearly formed, and I subjected them to examination under the microscope with a power of about 50 diameters. The faces were clearly to be made out. They belong to the monoclinic system, and their prevailing habitus in crystallisation is a combination of the two lateral pinacoids with positive and negative pyramids accompanied by one macrodome on the ends. The faces observed in an examination of five distinct crystals were (according to Naumann,—

$$\infty P\infty \cdot \infty P\infty + P \cdot - P \cdot + \tfrac{1}{2}P \cdot - \tfrac{1}{2}P \cdot + P\infty \cdot - P\infty \cdot$$

In considering the compounds of the iridium base with NH_4Cl, we find again a mixture of crystallised salts.

Preparation No. 1 consisted of sharply crystallised needles that looked almost black, and only by transmitted light showed a brownish-green colour. They were also monoclinic.

On analysis they prove, I think, to be the sought-for ethylen-iridium compound.

0·0713 grm. dried over H_2SO_4 lost on heating to 100° 0·0029 = 4·07 per cent:
gave 0·0850 grm. AgCl = 0·0210 grm. Cl = 29·49 per cent or 30·74 per cent of salt dried at 100°.

The iridium determination was made with magnesium, and was inaccurate as before.

The formula $IrCl_2C_2H_4NH_4Cl+H_2O=367·5$ demands Cl = 28·98 per cent, H_2O = 4·89, or anhydrous 30·47 per cent Cl.

Preparation No. 2 was of much smaller needles and of lighter colour.

Analyses show it to be of very similar composition to the potassium salt described above.

0·1207 grm. dried at 100° C:
gave 0·049 5 grm. metallic Ir. = 41·97 per cent:
gave also 0·2068 grm. AgCl = 0·0512 grm. Cl = 43·37 per cent.

$IrCl_4(C_2H_4)_2(NH_4Cl)_2$ = 0·502 gives Ir = 39·25 per cent and Cl = 42·43 per cent, and supposing it to lose some of the C_2H_4 at 100°, as stated above,

$$IrCl_4(C_2H_4)(NH_4Cl)_2$$

would give Ir = 41·50 per cent and Cl = 44·94 per cent.

The other two preparations of the ammonium salt analysed appeared under the lens to be mixtures of the iridium protochloride-ethylen salt and the iridium chloride-ethylen salt given above.

The results were—

0·1322 grm. dried at 100°:
gave 0·0609 grm. metallic iridium = 46·07 per cent.

0·1715 grm. dried at 100°:
gave 0·0784 grm. metallic iridium = 46·95 per cent.

$IrCl_2(C_2H_4)(NH_4Cl)+H_2O$ gives Ir = 39·25 per cent.

$IrCl_4(C_2H_4)_2(NH_4Cl)_2$ gives Ir = 23·61 per cent.

The existence of the base $IrCl_4(C_2H_4)_2$ I hope to settle definitely by renewed analyses of larger quantities.

While engaged with the preparation of the ethylen and iridium compound, the thought of the possibility of acetylen (C_2H_2) uniting with $PtCl_2$ or $IrCl_2$ led me to make some experiments in that direction. After a number of endeavours to form a platinum salt and analyses of the products (a detailed account of which is given in the original paper), I obtained negative results only. The existence of such a salt is highly improbable.—*American Journal of Science.*

ON A NEW FORM OF GAS APPARATUS.

By JOHN PARRY.

HAVING occasion to make daily analyses of the gases from the blast-furnace, finding the method of Bunsen very slow and tedious, and that Frankland and Ward's apparatus —though giving correct results — was unsuitable for daily use in the laboratory, I have designed the apparatus of which I enclose a sketch.

The measuring or gas tube, A, is enclosed in a glass cylinder filled with water, and dips into the mercury trough, B. The absorbing and eudiometer-tube, C, is connected with A by well-fitting elastic tubing of double thickness, firmly wired to the capillary glass tubing shown in the sketch.

The use of this apparatus hardly requires to be described. By alternately raising and lowering the mercury reservoir, R, both A and C are filled. The gas for analysis being then bubbled up into A, and measured with the usual precaution.

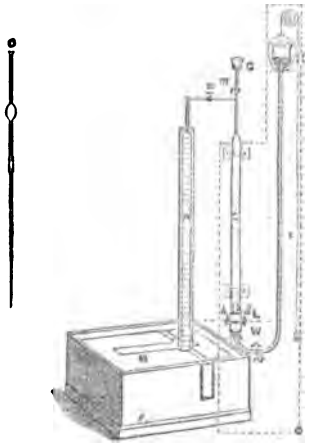
The liquid absorbent required is poured into the cup, G; R is lowered, M opened, thus drawing the test into C, a little being left in the cup to prevent admission of air.

The trap, N, is now opened, and the gas drawn into C; both M and N are to be kept closed while the gas is being subjected to the action of the absorbent. The latter must always be run into C as described, or it is drawn into the measuring-tube.

To clean C the gas is passed back into A, N is closed, and M opened, B lowered, and the mercury and absorbent allowed to flow out to about the level of L (see dotted line).

Unscrewing the nuts H and D, the lower part, W, is taken out, the test, &c., falling into a large basin placed under. While the mercury, &c., is falling down the tube C; water must be poured into the cup, G, for washing out traces of the absorbent.

The eudiometer-tube, C, is well washed with pure water, with the pipette, O (which consists only of an ordinary pipette joined to a long glass tube by a short piece of elastic tubing); it is evident the long tube may thus be conveniently passed up C, and the water blown through and up C, flowing down the sides of the tube into the basin.



The part W is made of iron or steel of the form shown, a plug of caoutchouc is firmly cemented into the short iron tube; the platina wires for explosions insulated in glass tubing, also the glass tube (wired to the elastic tubing, F, by which the reservoir, R, is raised and lowered) are passed air-tight through the caoutchouc plug.

The flanges, &c., W and L, should be well made with smooth true surfaces; a washer of caoutchouc is placed between the flanges, also the end of C presses down on the plug when the nuts H and D are screwed down.

The writer has used this apparatus for some time with very satisfactory results.

Analyses are rapidly and conveniently done; explosions are accomplished without difficulty, with far less trouble and risk than with the ordinary eudiometer; the gas for explosion may be expanded to any required extent by lowering R, and any risk of bursting C is thus entirely obviated.

Water may be substituted for mercury in the trough, B, but, of course, with less accurate results.

The eudiometer, C, may be supported by clamps attached to a long iron rod, and R raised or lowered by a pulley.

The writer attaches the eudiometer to a board to which a pulley is fixed, as shown by the dotted lines.

I am also much indebted to my assistant, Mr. James Needham, for his aid in arranging the details of the apparatus.

ANCIENT JEWISH GLASS.

By DUGALD CAMPBELL, F.C.S.

HAVING recently analysed some ancient glass which I obtained from Mr. Bessant, secretary to the "Palestine Exploration Fund," and which, that gentleman writes, "Is all from shafts *round the Temple*, and found at depths varying from 20 to 80 feet," and as its history is truly interesting and its composition is somewhat curious, an analysis, I trust, may not be considered out of place in your valuable journal.

The sample of glass furnished me weighed altogether about 3 ounces, and consisted of a number of small pieces, many of which in parts had undergone a change both in structure and colour by time and exposure.

The portion selected for analysis was from pieces which appeared to me to have undergone the least if any change, and the results were as follows, in 100 parts:—

Silica	69·30
Lime	8·50
Magnesia	0·55
Soda	13·79
Potash	1·49
Alumina	3·20
Oxide of iron (Fe_2O_3)	2·00
Oxide of antimony	0·29
Oxide of lead	trace
Phosphoric acid	0·80
Loss in analysis	0·08

The specific gravity of the glass is 2·430.

7, Quality Court, Chancery Lane, London,
December 11, 1871.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 7th, 1871.

Professor FRANKLAND, F.R.S., President, in the Chair.

WHEN the minutes of the Society had been read and confirmed, Mr. James L. Shuter was formally admitted a member, and the President announced that Mr. Gassiot had presented to the Society a greatly enlarged photograph of Daniell and Faraday.

The names of the following gentlemen were read for the first time:—Julian Louis Vanderstraaten, John Millar Thompson, Charles W. Vincent, Robert Barton, David Watson, William Thompson, William Forster, Henry James Helm, Thomas W. Fletcher, George Thomas Glover, and Thomas Eltoft.

For the third time—Charles Thomas, Benjamin Tanner, Hugh Paterson, Frederick Hicks, George Joseph Warner, Samuel William Moore, William John Wilson, William Gray, Robert Irvine, Reginald C. Woodcock, and Donald Munroe. After a ballot had been taken, these gentlemen were declared by the President to be duly elected.

Dr. J. H. GLADSTONE, F.R.S., then read a paper "*On Essential Oils*," Part II. The following is a short

abstract of this valuable and laborious communication, which is the continuation of one laid before the Society eight years ago. The first group of oils described includes —(1). That of citrin from the leaves of the lemon tree, which consists principally of a liquid boiling at 166° to 168°, sp. gr. 0·8459; refractive index for the line A 1·4680, and dispersion 0·273. (2). Lign aloes: a colourless oil having a pleasant odour, the greater part of which comes over at about 200°. (3). Pimento, from the seeds of *Myrtus pimento*, the greater portion of which distils at 243°, and is found to be entirely soluble in potash solution. It has a sp. gr. of 1·0436, refractive index for A 1·5281; dispersion about 0·416; and in other respects agrees with eugenic acid, so that the oil of pimento seems to differ from oil of cloves only in the hydrocarbon that is mixed with the eugenic acid. (4). Oil of Villvert, which is composed chiefly of an oil boiling at 280° to 283°; the action of sodium, however, showed that this was not homogeneous, but a mixture of two bodies.

The hydrocarbons from essential oils may be divided into three polymeric groups having the general formulæ $C_{10}H_{16}$, $C_{15}H_{24}$, and $C_{20}H_{32}$. The first group, $C_{10}H_{16}$, represents the greater number of these hydrocarbons, turpentine, orange, carraway, and more than twenty others. The second, $C_{15}H_{24}$, those from cloves, rosewood, cubebs, calamus, cascarilla, and patchouli, whilst the third is represented by colophene. That there is a broad line of demarcation between these three groups may be seen by comparing their physical properties set down in the following table, which also shows that the middle group is intermediate in its properties between the C_{10} and the C_{20} groups:—

	I.	II.	III.
Formula	$C_{10}H_{16}$	$C_{15}H_{24}$	$C_{20}H_{32}$
Vapour density	4·7	7·1	—
Specific gravity ..	0·846—0·880	0·904—0·927	0·939
Refractive index for A	1·457—1·467	1·488—1·497	1·5084
Dispersion	about 0·027	about 0·029	0·031
Sensitiveness	about 48	about 43	41
Boiling-point	160°—176°	249°—260°	315°

Many of the essential oils are mixtures of a hydrocarbon with a compound containing oxygen, of which but few have hitherto been carefully examined. Those obtained from citronella and from wormwood the author calls citronellole and absinthole respectively: they both have the composition $C_{10}H_{16}O$, the most remarkable point of difference between them being in their refraction equivalents; that of absinthole being 74·5, which agrees closely with the theoretical for $C_{10}H_{16}O$, while citronellole has 79·3 or 79·8 for its equivalent, a discrepancy almost the same as that found throughout the great phenyl group. Besides these he has examined cajeputole from oil of cajeput, and also the two carvoles from oil of carraway and oil of dill. These appear to be identical and not merely isomeric, and are remarkable for forming a crystalline compound with sulphuretted hydrogen having the composition $(C_{10}H_{14}O)_2H_2S$. The physical properties of menthole from spear mint, myristicole from nutmeg, and hydride of cumanyl from cassia, have likewise been examined; the latter has the enormous refraction of 1·6045 for the line A, and its refraction equivalent is also very abnormal.

The PRESIDENT said that the paper which Dr. Gladstone had communicated to the Society was one of great importance, since these physical qualities were facts which would remain unalterable however much our views as to the theory of their constitution might change, and although no one admired this class of investigation more than he did, he might also be allowed to speak a word in favour of certain chemical reactions which might, perhaps, enable us to relegate these hydrocarbons to their proper families, such as the action of chlorine or bromine on them. He should like to elicit from the author if he had tried any such reaction, so as to distinguish, for example, whether they were hydrides or radicals.

Dr. GLADSTONE said that bromine and chloride derivatives had been prepared, but that, in the cases he had tried, the result had been unsatisfactory.

Dr. WRIGHT asked whether his researches had led the author to consider the hydrocarbons as isomeric in the same way that the butylic hydrides are, or was it possible that many of these hydrocarbons might be identical, the difference in their properties being due to accidental impurities.

Dr. GLADSTONE replied that these oils were distinguished in some cases chiefly by their optical properties, and in others by their odour; citronellole was distinguished from absinthole by the former, having a considerably higher refractive equivalent than the theoretical, like that found in compounds throughout the great phenyl group; and again, the carvol from dill and the carvol from carraway were considered to be identical and not isomeric, from having the same odour; the same might be said of the eugenic acid from pimento and from cloves; identity of odour alone, however, is not sufficient to establish the identity of the hydrocarbons.

Dr. WRIGHT suggested that the odour might be due to a chemical change which the substance undergoes in the presence of oxygen and in contact with the mucous membrane of the nose. It was well-known that hydrocarbons which had been recently distilled over sodium had a less powerful odour than they had after being exposed for some time to the air.

Professor A. H. CHURCH would like to refer to the very interesting sulphur compound, $(C_{10}H_{14}O)_2H_2S$, in which an oxidised oil was united with sulphuretted hydrogen. Some eight or nine years ago he had described tasmanite, a resin found in a shale from Tasmania, which contained oxygen and sulphur in the same relative proportions as the above-mentioned compound. This resin, when treated with sulphuric acid, evolved sulphuretted hydrogen, so that the sulphur was in organic union with it, and not like the sulphur found in coal. In another fossil resin, dysodile, which he had examined the sulphur and oxygen only approximated to that ratio, but then it was not pure.

Dr. H. E. ARMSTRONG then read a paper entitled "*Observations on Nitrochlorophenols*," No. III. This communication comprises the experiments made to discover the relation between the dinitrochlorophenol melting at 110° to 111° and its isomers and the nitrodichlorophenols. For this purpose the author first converted dinitrophenol into dinitrochlorophenol by treating it with chlorine in the presence of antimony pentachloride. The compound melts at 110° to 111°, and is identical in every respect with that obtained by the nitration of dichlorophenolparasulphonic acid. The nitro-componnd was converted into the amidonitrochlorophenol in the usual way; this crystallises in long slender brass-yellow needles, which lose their water of crystallisation at 100° and melt at 140°. The chlorination of the orthonitrophenol was effected by the direct action of chlorine, but the product was somewhat difficult to purify. When this is done, however, the chloronitrophenol crystallises in white silky needles, which melt at 109° to 110°, and would seem to be identical with that obtained by Faust from dinitrochlorophenol. By the action of fuming sulphuric acid on dichlorophenol an acid was obtained, the potassium salt of which, when treated with nitric acid, gave a dinitrochlorophenol melting at 103°, apparently identical with that obtained by Stenhouse, by the action of chloride of iodine on picric acid; in most of its properties it bears a very strong resemblance to the isomeric phenol melting at 110°, the great difference being that all the salts of the former are orange-red, whilst those of the latter are yellow.

In reply to an observation of the President, Dr. Armstrong illustrated the possible constitution of some of the nitrochlorophenols according to Kekulé's view of the structure of benzol.

The meeting was then adjourned until Thursday, December 21.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 28th, 1871.

J. P. JOULE, D.C.L., LL.D., F.R.S., Vice-President, in the Chair.

MR. RICHARD SAMUEL DALE, B.A., was elected an Ordinary Member of the Society.

"*Encke's Comet, and the Supposed Resisting Medium*," by Professor W. STANLEY JEVONS, M.A.

The observed regular diminution of period of Encke's comet is still, I believe, an unexplained phenomenon for which it is necessary to invent a special hypothesis, a *Deus ex machina*, in the shape of an imaginary resisting medium. I cannot be sure that the suggestion I am about to make has not already been made, but I have never happened to meet with it; and therefore I venture to point out how it seems likely that the retardation of the comet may be reconciled with known physical laws.

It is asserted by Mr. R. A. Proctor, Professor Osborne Reynolds, and possibly others, that comets owe many of their peculiar phenomena to electric action. I need not enter upon any conjectures as to the exact nature of the electric disturbance, and I do not adopt any one theory of cometary constitution more than another. I merely point out that if the approach of a comet to the sun causes the development of electricity arising from the comet's motion, a certain resistance is at once accounted for. Wherever there is an electric current some heat will be produced and sooner or later radiated into space, so that the comet in each revolution will lose a small portion of its total energy. In the experiments of Arago, Joule, and Foucault the conversion of mechanical energy into heat by the motion of a metallic body in the neighbourhood of a magnet was made perfectly manifest. If then there is any magnetic relation whatever between the sun and comet, the latter will certainly experience resistance.

The question is thus resolved into one concerning the probability that a comet would experience electric disturbance in approaching the sun. On this point we have the evidence now existing that there is a close magnetic relation between the sun and planets. If, as is generally believed, the sun-spot periods depend on the motions of the planets, a small fraction of the planetary energy must be expended. I find, indeed, that a very brief remark to this effect was given in the memoir of the original discoverers of the relation, namely—Messrs. Warren de la Rue, Balfour Stewart, and B. Loewy. At p. 45 of their "Researches on Solar Physics" they add a small note to the following effect:—It is, however, a possible enquiry whether these phenomena do not imply a certain loss of motion in the influencing planets." As I conceive, no doubt can exist that periodic disturbances depending upon the motions of bodies must cause a certain dissipation of their energy, for if stationary the constant radiation of the sun could not produce any periodic changes, unless the sun were itself variable. Is there not, then, a reasonable probability that the light of the aurora represents an almost infinitesimal fraction of the earth's energy, and that in like manner the light of Encke's comet represents a far larger fraction of its energy? It is also worthy of notice that the tail of a comet is usually developed most largely at those parts of its orbit where the rate of approach or recess is most rapid, and where the electric disturbance would be correspondingly intense.

I do not, of course, deny that the resisting medium may nevertheless exist, or may by other observations or experiments be made manifest. But I hold that so long as other physical causes can be pointed out which might produce the same effect, it is quite unphilosophical to resort to a special hypothesis. Encke's comet ought not to be quoted as evidence of the existence of such a medium until electric disturbance is shown by calculation to be insufficient to account for the observed diminution of period.

"*On Cometary Phenomena*," by Professor OSBORNE REYNOLDS, M.A.

In all comets which have been observed through powerful telescopes there is an action going on which appears to be the result of evaporation. Jets of something like vapour are seen to issue from what is supposed to be a solid nucleus on that side which is towards the sun.

No such signs of evaporation are observed on the planets, nor is there any phenomenon that we are aware of which can be compared with this taking place on our earth. At first sight it seems strange that the sun should act to more effect on such small bodies as comets than it does on the larger bodies, even when the latter are nearer to it than the former. When, however, we come to look closer, I think good reason may be given for this; and I think that the difference of evaporation on the earth and on a comet may probably be the cause of electrical phenomena existing on the latter which certainly do not exist on the earth, and that the relation between the motion of the comet and the evaporation which might be expected to take place is precisely that which is observed between the motion and those appearances which I would explain on an electrical hypothesis.

The first thing to be done is to take notice of the following facts:—

(1.) Comets move in very eccentric orbits, whereas the planets move in orbits nearly circular.

(2.) Comets are supposed to be much smaller than the planets.

(3.) All the heat received by a body from the sun must be expended in one or other of the following ways:—

I. By radiation from the body.

II. By evaporating the materials.

III. Producing chemical change in these materials, or in electrical separation, &c.

That spent in the third method may be considered small.

Thus the heat which a body receives = heat radiated + heat spent in evaporation (1).

and

$$\frac{\text{heat radiated}}{\text{heat received}} = (\text{some constant}) \times \frac{\text{temperature of body}}{(\text{distance of sun})^2} \quad (2).$$

Now, the temperature at which any given material, say water, would evaporate would be much lower on a comet than on a planet, on account of the comet being so much smaller. For we may assume that there is a limit to the pressure which an atmosphere of vapour of unlimited extent can exert on the materials of the body it envelopes; then the limit of the temperature of the body will be that which will evaporate the material of the body under this pressure. It is clear that if there be such a limit it must increase very rapidly with the mass of the solid body, and hence that it would be much higher in the case of a planet than in that of a comet. This temperature may be called that of permanent evaporation, for as long as it was maintained the body would continue to evaporate; therefore the temperature of permanent evaporation of the planet would be much greater than that of the comet. That is, from equation (2.) the ratio of the heat radiated away to that received would be much less in the case of the comet than in the case of the planet, leaving, by equation (1,) a greater ratio for evaporation in the former than in the latter.

Now it is clear that our earth is well out of reach of this permanent evaporation; for the temperature at the equator is much less than 212° F., which is the boiling-point of water, its most volatile substance; and we may assume that the same is the case with all the other planets. If, however, the earth's atmosphere were removed, then evaporation would go on until there was another atmosphere formed which would hold the liquid in check. If, however, the earth had no attraction for vapour, or only a very slight one, then it would go on evaporating, in the

first place, until all the water was ice, and then it would spend all the heat it got from the sun in vapour. This, according to Sir J. Herschel's rate, is sufficient to melt ice just enough to reduce the diameter of the earth by an inch in about 4½ hours, and if it had to evaporate the water as well as melt the ice it would evaporate about 1 inch in 130 hours. Now, although this is a purely imaginary condition with regard to the earth, yet it must exist in the case of a small body like a comet, that is to say, there would be no liquid on the comet even when evaporation was going on, and, when the comet was near enough the sun, permanent evaporation would go on, which would only be ended by the comet removing itself, or by the exhaustion of the volatile material. This latter would take place supposing a comet should change its orbit, when near the sun, into a circular orbit, like a planet or meteorite. Even in the case of a periodic comet, there must be some exhaustion of the volatile materials. During the two hours in which the comet of 1843 was within close approximation to the sun, if the comet had been made of ice covered with lamp-black it would have received the heat of 47,000 suns according to Sir J. Herschel's computation. This would have evaporated the ice at the rate of 55 feet per hour on that side next the sun, or 13 feet over the whole comet. But in fact, owing to the protection of its atmosphere and imperfect absorbing power, it would have been much less than this, that is to say, the diameter of the comet would not have been reduced 10 feet. However, it may be that all the material evaporated is not lost. For, from the way in which comets approach and recede from the sun, it is probable that part of their orbit lies without, and part within, the range of permanent evaporation. Hence during part of their motion, when they are distant from the sun, condensation will be going on if there is anything to condense. This agrees well with the observed fact that a periodic comet makes less and less display each revolution. There the heat acts on the surface of the comet so that the less volatile substances would form a skin over the softer ones, through which the heat would have to pass, and through which the steam would have to force its way in jets.

Now such jets as these would act the same part as the jets in Armstrong's hydro-electrical machine, and the vapour which emerged would be charged with either positive or negative electricity, as the case might be, the solid being charged with electricity of the opposite kind.

The vapour, as it formed an atmosphere round the nucleus, would then discharge some of the electricity back. This would cause those portions which were nearest the nucleus to be bright (self-luminous), brighter than the more distant. Although the variations in temperature would be slight, yet as the atmosphere moved outwards from the nucleus there would be expansion, and consequently condensation; hence the outside of the coma might be illuminated by the direct rays of the sun, or we might have several bands of condensed vapour so illuminated, as suggested by Sir J. Herschel. On the other hand, I think this illumination may be due, at least in part, to the electric action between the matter of the comet and matter previously in space. This point will probably be settled by Mr. Huggins when the next large comet makes its appearance.

The period of greatest display is not reached till after the comet has passed its perihelion, and the tail is visible for much longer after this than it was before it. Now, if we suppose the comet to be made up of hard and volatile substances, owing to the heat absorbed by the hard substances the evaporation would lag somewhat behind the position of the comet, and consequently be greatest after it had passed its perihelion distance, just as a thick retort will continue to boil after the lamp has been removed. Hence we see that, if the evaporation causes electrical separation in the comet, this will be at its maximum just when the display is observed to be at a maximum.

This communication is not intended as an alteration of the views which I expressed in a former communication, but as an extension of those views, for I formerly advanced no hypothesis as to the possible cause of the electricity. Also, with regard to the formation of tails, I wish to add somewhat to my former remarks. Professor Norton has shown that the primary tail of Donati's comet might have been formed by matter emitted by the comet, and repelled by the sun with a force equal to from 0·75 to 0·55, the attraction of the sun for ordinary matter; the matter repelled with 0·55 forming the following edge, that with 0·75 the leading edge of this tail. Professor Norton suggests that these forces may be electrical or magnetic.

Accepting Professor Norton's calculations as correct, it is certain that if, for some cause or other, the sun repelled negative electricity, and there were two streams of electrified matter leaving the comet, charged in the ratio of 0.75 to 0·55, these would be repelled in the ratio he wants; at the same time I do not think he has sufficiently taken into account the repulsion one stream would have on the other.

Professor Norton does not suggest an explanation of the straight tails seen with most comets as primary or secondary tails. These I maintain can only be explained on the supposition that there is matter in space in the form of gas, and that the comet causes it to be electrically illuminated by a brush, as I stated in my former communication.

Again, if the tail of the comet be electricity of one kind (say negative), leaving the comet never to return, then the comet must leave the neighbourhood of the sun with a charge of positive electricity, which, as it gets further from the sun and evaporation becomes feeble, will in time overpower the negative electricity in the atmosphere, which will then be attracted by the sun instead of repelled, and if the comet has any tail it will now turn away from the sun; in which condition it will probably remain until its approach to our sun, or some other star, again cause it to become negative and turn round. In this case a periodic comet would turn its tail round at definite points in its orbit, and, owing to the lagging of the symmetry of the comet's appearance in its orbit, the point of turning will be nearer to the sun on its return than on its departure. Now it seems, from a remark of Professor Airy, that comets, when first seen, often have their tails before them, and that such is the case with Encke's comet now visible.

GLASGOW PHILOSOPHICAL SOCIETY.

(Chemical Section).

Ordinary Meeting, December 4th, 1871.

Dr. Wallace, F.R.S.E., in the Chair.

Dr. John Clark read a paper on "*The Analysis of Chrome Ores, and a New Method of Estimating the Oxide of Chromium.*" He first referred to the discrepancies which Dr. Genth, in 1862, had noticed between his own analyses of such ores and those of English chemists. Discordant results still exist, and the consumers of chrome ore complain that in the manufacture of bichromate of potash there is a loss of oxide of chromium which they can only account for on the supposition that the chemist reports too high a result. Such complaints are not altogether unfounded, and the author considered that, while some discrepancies may be due to differences in the samples, the greater number must be due to the inexperience of the analysts and to the difficulty of obtaining correct results by the ordinary methods of analysis. Dr. Genth recognised the impossibility of obtaining, by washing alone, an oxide of chromium precipitate perfectly free from alkali after fusing the ore with bisulphate of potash, and he recommended that, before weighing, the ignited precipitate should be boiled with water containing

sulphurous acid to reduce the chromate which had been formed, and that the resulting oxide should be precipitated with ammonia. By this means the weight of the precipitate of oxide of chromium is greatly reduced.

Dr. Clark said he had never obtained a perfectly pure oxide by this method, and instead of boiling with water containing sulphurous acid, he had been in the habit of using dilute acetic acid, and estimating chromic acid thus removed with the diluted solution of the double sulphate of ammonium and iron of known strength. The oxide of chromium, in the form of chromate, usually amounts, even in the most carefully washed precipitates, to 0·76 per cent. The author referred to the process of M. Clouet, manufacturer of bichromate of potash, Havre, as one which gives very good results. This consists in fusing pulverised chrome ore with from five to six times its weight of pure carbonate of soda in a platinum crucible for five or six hours at a bright red heat, without the addition of any oxidising agent, reducing the purified chromic acid formed with alcohol in presence of hydrochloric acid, and precipitating the oxide of chromium with ammonia. But although this process yields the correct amount of oxide of chromium, it is not well adapted for the laboratory on account of the length of time required for the complete oxidation of the oxide of chromium in the ore.

Dr. Clark stated that perfectly accurate results might be obtained by the following process, which is both simple and expeditious:—25 grains of the finely-pulverised ore are intimately mixed with 5 parts of hydrate of sodium and 3 parts of calcined magnesia, and the mixture is exposed in a platinum crucible in a Bunsen flame for ¾ of an hour, with the lid on. Oxidation at once takes place under the influence of the hydrate of sodium and magnesia, and it is practically complete in less than an hour. The crucible with its contents is then placed in a basin containing water, the contents being washed out with water as far as possible, and the operation completed by using dilute sulphuric acid quite free from nitric acid. An additional quantity of dilute sulphuric acid is added and then the whole is heated. Everything will dissolve, except, perhaps, a few flakes of silica. To the clear yellow solution is added a weighed quantity of double sulphate of iron and ammonium of known strength, and more than is sufficient for the reduction of the chromic acid. The excess of unoxidised iron is then estimated with a weak standard solution of bichromate of potash, and the amount of oxide of chromium in the ore calculated from the quantity of iron oxidised. The results obtained by Dr. Clark by the process now described seldom vary 0·2 per cent. The process has been submitted to a number of chemists, including the Director of the School of Mines in St. Petersburg, who has not only expressed a very favourable opinion of it, but who has also adopted it in the testing of the Russian ores.

Dr. Clark gave a brief digest of M. Clouet's paper (*Annales de Chim. et Phys.*), and stated that he had never been able by Clouet's process to remove the alumina completely soluble in water by fusion with carbonate of sodium, and that he had always found a considerable proportion of the alumina in the precipitate, which M. Clouet regards as pure oxide of iron. He also stated that in the many analyses which he had made of chrome ores he had never found the composition to agree with any of the formulæ given by M. Clouet; still he did not say that the protoxide of iron and the sesquioxide of chromium did not exist in definite proportions. However, if they did exist in definite proportions, it must be necessary to frame other formulæ to represent the relationship of the two compounds in addition to those mentioned by M. Clouet.

A short discussion followed in which Dr. Wallace and Dr. Thorpe took part, the former referring to the isomorphous character of magnesia and protoxide of iron, and the sesquioxides of chromium and iron, as a circumstance which might not have been observed by Clouet in his analyses and in framing his formulæ.

Dr. T. E. THORPE, F.R.S.E. made a short oral communication on "*A Method of Taking Specific Gravities.*" He exhibited and described an exceedingly neat and ingenious apparatus which he had devised for taking the specific gravities of certain volatile compounds, more especially the oxychlorides, such as—

$$POCl_3,\ VOCl_3,\ PSCl_3,\ CrO_2Cl_2,\ SO_2Cl_2.$$

By means of the apparatus Dr. Thorpe stated that he had been able to obtain the following results in respect of oxychloride of phosphorus, taking three operations:—7·47062, 7·47014, and 7·47019; while oxychloride of vanadium gave the following results:—8·06408, 8·06381, and 8·06450. He explained that the instrument might, with more or less structural modification, be applied to other uses, such, for instance, as determining expansion coefficients; as a pipette for brominating hydrocarbons, and as a specific gravity where volatile hydrocarbons are concerned.

The apparatus excited much interest among the members, and was greatly admired on account of its ingenious arrangements.

CORRESPONDENCE.

SMOKE DRAINAGE.

To the Editor of the Chemical News.

SIR,—I have to thank you for naming the fact that the suggestion of the Rev. B. W. Gibsone is merely a repetition of that of which I gave a detailed statement with all the data needful for proving its practicability in the paper read before Manchester Literary and Philosophical Society, and published by me in 1857. A copy of this pamphlet I shall be most happy to transmit to Mr. Gibsone on his furnishing me with his address. I am sorry I missed seeing his letter in the *Times*, else I should have referred to it sooner. I beg, however, to demur most decidedly to your statement that I had found difficulty in obtaining sufficient draught, &c, to effect the object.

Where the matter has been at all attempted, I believe there has been no difficulty of the sort found to exist, and, had Mr. Waterhouse's design for the new Law Courts been adopted, as I believe it ought, you would have had the scheme in its integrity carried out in that building with 1000 fires and ventilating flues turned into the sewerage below, and carried up in one shaft 300 feet high. Anyone who will go over the calculations in my pamphlet will see that the only practical difficulty is the expense of re-constructing our flues and sewerage. I may say that the strong language I used in 1857 against the London sewage scheme then only contemplated, I fully endorse now it is completed.—I am, &c.,

PETER SPENCE.

Pendleton Alum Works, Manchester,
December 11, 1871.

MISCELLANEOUS.

The Rupture of Iron Wire by a Blow.—At the last meeting of the Manchester Literary and Philosophical Society, Mr. John Hopkinson, B.A., D.Sc.. detailed some experiments on this subject, the results of which are—1st. That if any physical cause increase the tenacity of wire, but increase the product of its elasticity and linear density in a more than duplicate ratio, it will render it more liable to break under a blow. 2nd. That the breaking of wire under a blow depends intimately on the length of the wire, its support, and the method of applying the blow. 3rd. That in cases such as surges on chains, &c., the effect depends more on the velocity than on the momentum or *vis viva* of the surge. 4th. That it is very rash to generalise from observations on the breaking of structures by a blow in one case to others even nearly allied, without carefully considering all the details.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, November 13, 1871.

This number opens with a brief but well deserved eulogium on the late illustrious Sir Roderick Impey Murchison, who was one of the Foreign Associates of this eminent scientific institution. Due honour is done to the memory of the celebrated deceased *savant* by his eminent *confrère*, the eloquent M. Dumas.

This number contains, in addition to several papers relating strictly to other departments of science, the following papers relating to chemistry:—

Thermal Researches Relating to Crystalline Dissociation.—P. A. Favre and C. A. Valson.—The contents of this very lengthy essay are not suited for useful reproduction, owing to the fact that it would require the reproduction of a very lengthy series of tabulated forms exhibiting results of experiments.

Salant.—E. P. Bérard.—Under the name of salant, also *salan* and *salobré*, is understood, in those Departments of France which border on the Mediterranean, a light saline crust found on the soil of certain portions of the localities alluded to, which soil is almost entirely sterile and unfit for any plants to grow on. The author has made some researches on this matter, and paid more particular attention to the alluvial deposit met with near Agde (Département de l'Hérault). It appears that this *salan* is chiefly composed of chloride of sodium and the sulphates of lime and magnesia. The contents of this paper are, however, chiefly of local interest only.

Formation of Precipitates.—Dr. Berthelot.—The continuation of the exhaustive essay on this subject, this portion treating on the separation between the acid and the base of the salts.

Most Economical Arrangement to be Given to Galvanic Elements in Reference to their Polar Electrodes.—Th. du Moncel.

November 20, 1871.

This number contains the following papers more especially relating to chemistry:—

Thermal Researches on Electrolysis.—P. A. Favre.—The continuation of this very lengthy and exhaustive essay.

Velocity of Sound in Sonorous Pipes.—J. Bourget.—An algebraico-physical essay; an observation also applicable to the following paper:—

Transversal Vibrations of Strings and Thin Laminæ.—E. Gripon.

New Phenomenon of Phosphorescence Produced by Frictional Electricity.—Dr. Alvergniat.—A vacuum is first made into glass tubes about 45 centimetres in length. After the introduction into these tubes of a small quantity of either chloride or bromide of silicium, the pressure inside these tubes having been reduced to 12 or 15 millims., the same are sealed by means of the glass-blower's lamp. When such tubes are next rubbed with a piece of silk, there appears inside the tubes a bright luminous flash, which exhibits a rose colour with the chloride, and a yellowish green colour with the bromide, of silicium. Only when a more perfect vacuum is made in these tubes the induction spark produces a luminous phenomenon in them when the spark passes through, but then the phosphorescence by friction entirely disappears.

Continuation of the Essay on the Formation of Precipitates.—Dr. Berthelot.—This portion treats on the change which occurs in the state of aggregation.

Conversion of Albuminoid Matters into Urea by the Action of Permanganate of Potassa.—E. Ritter.—The contents of this paper contain the record of a series of experiments made by the author simply with the view to ascertain whether the researches of Dr. Béchamp on this subject, which have been repeatedly (even very recently by Dr. O. Loew) contradicted and declared to be wrong, are or are not correct. The author of this paper states that, by correctly following the directions given by Dr. Béchamp, he (Dr. Ritter) has perfectly succeeded in converting albumen, fibrin, and gluten into urea, by the action of the salt alluded to, but the quantities of urea so obtained are very small, as may be inferred from the following data:—30 grms. of albumen yielded 0·09 grm. of urea; fibrin, 0·07 grm.; gluten, from 0·21 to 0·31 grm.

This number also contains several original papers relating to physical geography, geology, astronomy, meteorology, and natural history.

The American Journal of Science and Arts, November, 1871.

This number contains the following original papers relating to chemistry and collateral sciences;—

On Some Phenomena of Binocular Vision.—J. Leconte.—The sixth portion of this lengthy essay, illustrated by several woodcuts.

Variations of the Temperature of the Human Body.—Dr. B. F. Craig.—An important physiological paper, recording a series of experiments.

Precise Geographical Position of the Large Masses of Meteoric Iron in North Mexico, with the Description of a New Mass—the San Gregorio Meteorite.—J. Lawrence Smith.—In the introduction to this paper, the author relates what has become known about the meteorites of North Mexico by the labours of the Boundary Commission. The immense mass of meteoric iron—the San Gregorio meteorite—is situated on the western border of the Mexican desert. Its shape (illustrated by a woodcut in the original) bears some likeness to that of a blacksmith's anvil. Its greatest length is 6 feet 6 inches; it is 5 feet 6 inches high, and 4 feet thick at its base. On one part of its surface "1821" is cut with a chisel, and above this date is the following inscription:—"Solo dios con un poder este fierro destruerá, por que el en mondo non habra quien lo puedo deschacer" (Only gods can have the power to break up this mass of iron, for there is no body on earth who can break it to pieces). The weight of this mass is nearly 5 tons; it lies near to the spot where it hss fallen, but nothing is further known of its history. The author has examined a small detached specimen of this stone, which is of the softer meteoric iron (sp. gr. = 7·84). Chemical composition percentically:—Iron, 95·01; nickel, 4·22; cobalt, 0·51; copper, minute traces; phosphorus, 0·08. The Mexican desert has an extension of 400 miles from east to west, and 500 miles from north to south = an area of 200,000 square miles. The United Kingdom has an area of 121,518 square miles.

Iridium Compounds Analogous to Ethylen and Protochloride of Platinum Salts.—S. P. Sadtler.—Reproduced in present number.

The Paragenesis and Derivation of Copper and its Associates on Lake Superior.—R. Rumpelly.—The continuation of a lengthy essay on this subject.

Observations on the Colour of Fluorescent Solutions.—Dr. H. Morton.

As is usual, this number contains some excellent original papers relating to natural history, astronomy, geology, and botany.

Zeitschrift für Chemie von Beilstein, No. 12, 1871.

This number only contains the following original paper:—

On Dibromo-Benzol-Sulpho Acid.—A. Wölz.—In the introduction to this paper, the author briefly refers to the researches of Dr. R. D. Williams on this same subject (see CHEMICAL NEWS, vol. xxiv., p. 193), stating that the last-named author's results of experiments do not materially differ from those obtained by himself. The dibromo-benzol-sulpho acid fuses at between 97° and 98°. The following salts of this acid are briefly described:—Barium salt, $(C_6H_3Br_2SO_3O)_2Ba$, a beautiful crystalline substance, difficultly soluble in cold, readily so in hot, water; potassium salt—

$$C_6H_3Br_2SO_3OK+H_2O,$$

obtained by double decomposition from the baryta salt, is soluble in water and in alcohol; calcium salt, $(C_6H_3Br_2SO_3O)_2Ca+9H_2O$, a crystalline efflorescent salt, readily soluble in water and alcohol; lead salt, not very soluble in water; copper salt, a very rapidly efflorescing green-coloured salt, very soluble in water; ammonium salt—

$$C_6H_3Br_2SO_3ONH_4,$$

a needle-shaped crystalline salt, very soluble in water. The acid alluded to is isomeric, not identical, with that obtained many years ago by Schmitt.

Le Moniteur Scientifique Quesneville, Nos. 357 and 358 (double number), November 1 and 15, 1871.

This number contains the following original papers and memoirs relating to chemistry and collateral sciences:—

Historical Notice on the Labours which have Led to the Synthesis of Indigotine.—A. Rosenstiehl.—We regret that the contents of this very excellent essay do not admit of any useful abstraction.

Constitution of Milk and of Blood.—Dr. J. Dumas.—This paper was read last summer at Genève, but it is impossible to give an abstract without detracting from the merits of the essay.

Observations on the Alteration of Well-Water by the Proximity of Burial-Grounds.—J. Lefort.—The contents of this paper bear more especially upon the effect of a decree, dated March 7, 1808, whereby it has been enjoined that no wells shall be bored or dug out at a less distance than 100 metres in all directions from any burial-ground. The author, having found that not only in many country villages but also in several towns this regulation has not been observed, has made some experiments on the water of a well at Saint Didier (Département de l'Allier). This locality is situated on an alluvial soil; this water is used for drinking purposes by the parish priest and a portion of the inhabitants, and, on examination, the author found it to contain not only a large proportion of ammoniacal salts but also, on evaporation, to leave a very large quantity of a dark-coloured organic matter mixed with carbonated salts, which, on being mixed with some hydrochloric acid, gave off an offensive carbonic acid gas, the smell being somewhat akin to a mixture of a concentrated solution of glue and butyric acid. The well is very deep, and the water is quite clear and bright, but exhibits, especially in summer time, a very vapid taste, while, in the warm season of the year, it rapidly becomes putrid. The author comes to the conclusion that, in any soil, a well dug at the

distance of 100 metres from either burial-grounds or battle-fields is quite useless to protect the water of even deep wells from becoming so contaminated with organic and other injurious matter as to make it imperatively necessary to make new and sound regulations on this subject, so as to avoid wells (for obtaining potable water for domestic use) being sunk without a stringent inquiry as to where the water comes from, and through what strata of soil it may have to pass.

Remarks on Dr. A. Taylor's Process for Detecting Blood Stains.—J. Lefort.—A medico-forensic essay of value.

Practical Instruction in Beet-Root Sugar Preparation.—Dr. Vivien.—An excellent and clearly written paper on the so-called boiling (really evaporation of water from a saccharine juice) of sugar.

Boiling of Food at a Temperature below 100°.—Dr. Jeannel.—The contents of this lengthy essay record the results of a series of experiments, from which it appears that food (meat as well as vegetables) boiled at 95° is more nutritious and of better flavour than when boiled at or above 100°. The author illustrates this point by what takes place in mountain localities (every 100 metres' rise above sea level make a difference of $\frac{1}{3}$° C. less in the boiling-point of water); as, for instance, at Potosi (Bolivia), at 4061 metres above sea level, and an average barometer reading of 454 m.m., the water boils at 86 2°; at Mexico, 2277 metres above sea level, 569 m.m. barometer, water boils at 92·1°; at Briançon (France), 1321 metres above sea level, 643 m.m. barometer, at 95·4°, as by the action of the so-called Norwegian cooking apparatus.

Les Mondes, December 7, 1871.

Mineral Riches of Japan.—M. Sévoz.—In the shape of a letter addressed to the excellent editor of this periodical, the author communicates some interesting facts on the metallurgical industry of the country just named, wherein coals are found, and gold and silver, copper, lead, and iron are extracted from their ores or from the rocks wherein they are imbedded. The Japanese work iron by an imperfect method called the Catalan method. After smelting, the slag still contains 40 per cent of metallic iron; a small blast-furnace will, however, be built by the author at the locality where this iron ore is found. The natives are excellent miners, but were until lately unacquainted with the use of gunpowder in mining operations.

Experiments made by Thermo-Dynamics.—F. Tommasi.—For the purpose of proving the possibility of converting into dynamical work the dilatation produced in liquids by heat; the facility to utilise this motive force for the purpose of working hydraulic presses. Illustrated by a series of woodcuts.

La Revue des Scientifique de la France et de l'Etranger, November 4, 1871.

This number does not contain any original papers relating to chemistry.

December 2, 1871.

Although the titles of the following original papers do not strictly belong to the subject-matter usually treated in our columns, we call attention to them for their general scientific interest:—

International Congress of Anthropology and Pre-Historic Archæology; Meeting at Bologna, Italy.—A highly valuable record of well observed and digested facts.

Origin of the Sedimentary Terrains (Rocks, Coal, &c.)—Ch. Contrejeau.—A very clear *exposé* of geological facts.

December 9, 1871.

In this number we meet with the—

Compte Rendu of the Daily Meetings of the Last Session (September) of the International Congress of Anthropology and Pre-Historic Archæology at Bologna.—M. Cazalis de Fondouce.

Present State of Aërial Navigation and the Attempts made to Steer Air-Balloons.—W. de Fonvielle.

Polytechnisches Journal von Dingler, first number for November, 1871.

Continuation and End of Essay on Blast-Furnaces for Making Pig-Iron.—C. Schinz.

Contribution to the History of the Recovery of Sulphur from Alkali Waste.—L. Mond.—The real gist of this paper turns upon a question of priority of invention. It appears that the author has been very unjustly accused in papers published abroad of purloining and patenting inventions not his own, but the property and invention of others. The author, in this paper, proves not only that there is not the remotest ground for such base assertions, but that he was the first who devised a practicable and advantageous method for extracting sulphur from alkali waste on the large scale now some twelve years ago.

Water contained in some of the Double Sulphates.—H. Rheineck.—Protosulphate of iron and ammonia, $NH_4FeS_2O_8+5HO$—equivalent, 187·4; water, 24·72 per cent. Protosulphate of iron and potassa, $KFeS_2O_8+5HO$—equivalent, 208; water, 21·63 per cent. Ammonio-sulphate of magnesia, $MgNH_4S_2O_8+6HO$—water, 33·33 per cent. Ammonio-sulphate of copper, $CuNH_4S_2O_8+6HO$—water, 27·04 per cent.; and $CuSO_4$, 39·56 per cent. The author has analysed these salts volumetrically, care being taken to obtain the substances in a pure and perfectly crystalline state.

Suggestion for the Means of Preventing as much as possible Explosions occurring with Detonating and Explosive Substances, more especially Fulminate of Mercury, when prepared for the purpose of Filling Percussion Caps.—Dr. Ph. Neumann.—This paper bears entirely upon the making of percussion caps. The author proves, by a series of facts elucidated by experiments, that the operations of granulation and mixing of the fulminate are best and most safely conducted in vacuum.

Phenomena of Fermentation.—H. Rheineck.—However valuable in a scientific sense, the contents of this paper are not well suited for any useful abstraction.

Brewing Industry of the Austro-Hungarian Empire.—G. Yoback.—A lengthy statistical essay on the beer production of the country alluded to.

NOTES AND QUERIES.

Comparative Tables of Hydrometers.—(Reply to L. C.).—You will find the latest comparative tables of hydrometers in *Zeitschrift für Analytische Chemie*, von R. Fresenius, 1870, p. 437.—V. C.

Comparative Tables of Hydrometers.—(Reply to L. C.).—You will very likely find what you desire in "Sammlung Physikalischer Tabellen," von Dr. E. L. Schubarth: Berlin, 1849 or later, 8vo., 200 pages.

Naphthalic Acid.—(Reply to "Naphthaline").—By prolonged boiling of naphthaline with nitric acid, the former body is converted into a mixture of oxalic and naphthalic acids. Consult, further, Miller's "Elements of Organic Chemistry," part iii., p. 707, 4th edition.

Apparatus for the Liquefaction of Gases.—(Reply to S. T.).—Consult Müller-Pouillet's "Lehrbuch der Physik," Gehler's "Physikalisches Lexikon," or Prechtl's "Technologische Encyclopedie," all of which books you may inspect at the Patent Office Library.

Gas-Proof Fabric.—(Reply to "L.R.C.P. Ed.").—The Xylonite Company (Limited), 7, Great Winchester Street Buildings, London, E.C., are supplying hospitals, &c., with a cheap kind of collodion, which is also made into the finest of tissues both with and without a fibrous material; in some respects it is superior to either gutta-percha or india-rubber.—S. E. P.

Adulterations in Food and Drink.—In answer to "An Amateur Chemist," I would repeat that hackneyed saying "there is no royal road to chemistry," and especially to the detection of adulterations in food and drink. Very few illicit admixtures are capable of detection by chemical means; the majority require considerable acquaintance with the microscope, and many are determined by mechanical means —*i.e.*, such as density, &c. Hassall's book is one of the best, and "An Amateur Chemist" will find no shorter way to the subject than by a careful perusal of such a one.—S. W. MOORE.

Heat and Electricity.—No doubt Mr. Wilson is right as to what ought to be done for a full determination of the laws of this subject. I hope soon to have time to carry out experiments more fully; meanwhile I only wished to call the attention of experimentalists to the matter. Till it is more fully investigated it is scarcely worth while to say anything more about it. But, perhaps, I may add that I found, quite contrary to what might be expected, that a zinc and sulphate of copper battery giving a current of 75° on the tangent galvanometer would keep hot three or four times the length of wire which a zinc and platinum element would, though, from the electro-motive power of the elements respectively, one would have expected just the contrary result. However, after a short time I hope to experiment fully and ascertain whether the laws derived from elements of the same kind apply to elements of different kinds.—H. HIGHTON.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 18th.—London Institution, 4. Prof. Huxley, LL.D. F.R.S., on "Elementary Physiology."
—— Medical, 8.
—— Anthropological, 8.
TUESDAY, 19th.—Civil Engineers, 8.
WEDNESDAY, 20th.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 21st.—Royal, 8.30.
—— Zoological, 4.
—— Chemical, 8. Mr. H. Bassett, "On Eulyte and Dyslyte."
—— Philosophical Club, 6.
FRIDAY, 22nd.—Quekett Microscopical Club, 8.

TO CORRESPONDENTS.

F.R.C.S.—(1). You will find all the information you require in Brande's "Manual of Chemistry," 6th edition, vol. i., pp. 457 to 464. (2). There are several kinds of apparatus in use for condensing carbonic acid gas; Natterer's is readily worked.

L. Mond.—Your communication has received attention.

C. T. Kingzett, C. Crump, V. Cruse, W. Valentin, and J. Parry, are thanked for their communications.

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THE CHEMICAL NEWS.

VOL. XXIV. No. 630.

NOTES ON FLUORESCENCE.

By HENRY MORTON, Ph.D.

(CORRECTION).

THROUGH a series of accidents, I was prevented from obtaining access to Professor Stokes's papers on fluorescence in the *Philosophical Transactions* until the present time. I thus failed to be aware that two observations casually mentioned in my previous "Notes" or "Observations" on this subject had been previously made and discussed by this eminent physicist.

The points to which I allude are the effect of hydrochloric acid on quinine sulphate and the increase of fluorescence in solutions of the latter substance by dilution.

ON FLUORIDE OF SILVER.*

By G. GORE, F.R.S.

PART III.

IN this communication the author has finally shown that the action of iodine, under the influence of heat (including the process described by Kammerer, *Phil. Mag.*, 1863, vol. xxv., p. 213, for the isolation of fluorine), does not liberate uncombined fluorine, but produces fluoride of iodine and iodide of silver, a double salt, composed of iodide of silver and fluoride of platinum, being produced at the same time by corrosion of the platinum vessels, if the temperature approaches a red heat.

The fluoride of iodine produced is a highly volatile and colourless liquid, does not corrode mercury or red-hot platinum, corrodes glass at 60° F., and crystals of silicon at a red heat, also platinum in contact with argentic fluoride in a state of fusion; it instantly turns a deal splint black, fumes powerfully in the air, and is decomposed with violence by water into hydrofluoric and iodic acids, in accordance with the following equation,

$$IF_5 + 3H_2O = 5HF + HIO_3.$$

It dissolves iodine, and is absorbed by that substance; it is also absorbed either by argentic fluoride or iodide when those substances are cooled in its vapour, and may be expelled from them at a red heat. Its vapour quickly darkens the colour of a deal splint, and very gradually turns paraffine brown.

The platinum vessels in which the reaction with iodine was effected were considerably corroded (but less so than when bromine or chlorine were employed), and many expensive vessels were rendered useless by this cause during the experiments.

No chemical change occurred on heating argentic fluoride to redness with pure carbon.

By heating this fluoride to redness in a current of dried coal-gas, it was wholly reduced to metallic silver, hydrofluoric acid and tetrafluoride of carbon being evolved.

In liquid cyanogen, argentic fluoride neither dissolved nor suffered chemical change, but at a low red heat, in a current of dry cyanogen gas, it was entirely reduced to metal, either nitrogen and tetrafluoride of carbon, or fluoride of cyanogen being liberated. An aqueous solution of silver fluoride was precipitated by passing a prolonged current of cyanogen gas through it. Fluoride of silver was also decomposed by fusion with paracyanogen.

Argentic fluoride was not dissolved or chemically changed by immersion in anhydrous liquefied hydrocyanic acid, but by passing the dry acid in vapour over the red-hot salt, the latter was decomposed and metallic silver liberated. Aqueous hydrocyanic acid readily precipitated a solution of argentic fluoride.

Fluoride of silver was not decomposed by heating it to redness in an atmosphere of carbonic oxide or carbonic acid gases.

By fusing the fluoride in a current of vaporous terchloride of carbon, it was wholly converted into argentic chloride, the vessels being much corroded, and an insoluble double salt of platinum and silver formed. Similar results took place on using tetrachloride of carbon. Silver fluoride was insoluble, and remained unchanged in liquid tetrachloride of carbon at 60° F.; and terchloride or tetrachloride of carbon had no chemical effect upon an aqueous solution of the silver-salt. A solution of bromine or iodine in tetrachloride of carbon was quickly decolourised by agitation with small particles of argentic fluoride.

Crystals of boron did not decompose fluoride of silver at a low red heat, nor chemically change at 60° F., an aqueous solution of the salt containing either free hydrofluoric or nitric acids.

Vitrified boracic acid violently decomposed fluoride of silver in a state of fusion, emitting copious white acid fumes, but it had no chemical effect upon an aqueous solution of the salt at 60° F.

By placing crystals of silicon upon argentic fluoride in a state of fusion, they become at once red-hot, undergoing rapid combustion, and evolving fluoride of silicon. A lump of fused silicon slowly decomposed an aqueous solution of fluoride of silver, setting free metallic silver in crystals. Crystals of silver behaved similarly, but much more rapidly, and evolved abundance of gas if the solution contained free hydrofluoric acid; on adding nitric acid to this mixture, bubbles of spontaneously inflammable silicide of hydrogen gas were evolved and ignited.

Pure and dry precipitated silica added to fluoride of silver, at a temperature of low redness, evolved much heat, with violent action, and set free metallic silver.

No chemical change took place on passing fluoride of silicon over red-hot fluoride of silver.

Argentic fluoride in a state of fusion is rapidly decomposed by sulphur with evolution of heat; fluoride of sulphur is at the same time produced, and argentic sulphide formed. To ascertain whether fluoride of sulphur is a gas or a volatile liquid, an apparatus called a "gas collector" was devised and employed, and a full description of its construction is given. By using this apparatus, substances may be heated without contact with the external air, and without subjecting the joints of the apparatus in which they are heated to leakage by expansion or contraction of the gaseous contents.

Fluoride of sulphur was found to be a heavy colourless vapour, uncondensable at the temperature of melting ice and at the ordinary atmospheric pressure. It corrodes glass, fumes strongly in the air, and has a characteristic and very powerful dusty odour, not very unlike that of a mixture of chloride of sulphur and sulphurous anhydride. Sulphur rapidly decomposed an aqueous solution of argentic fluoride.

Sulphurous anhydride passed over fluoride of silver at an incipient red heat, produced little or no decomposition of the silver-salt. Vaporous fluoride of sulphur also produced no visible effect.

By passing the vapour of liquid chloride of sulphur over the fluoride in a state of fusion, chemical action occurred, a vapour was evolved which corroded glass, and possessed a dusty odour, but did not condense to a liquid; it was probably fluoride of sulphur. The saline residue consisted of argentic chloride and sulphide. A solution of argentic fluoride was decomposed by agitation with liquid chloride of sulphur, hydrofluoric acid being evolved, and argentic chloride and sulphide produced.

Argentic fluoride did not dissolve in bisulphide of carbon. By passing the vapour of the latter substance over the silver-salt at a red heat, a chemical change took

* Abstract of a Paper read before the Royal Society.

place, and a fuming acid vapour was evolved, in accordance with the following equation:—$4AgF + CS_2 = Ag_2S + CF_4$. A solution of bromine or iodine in bisulphide of carbon was rapidly decolourised by agitation with particles of argentic fluoride, and the liquid acquired the odour of tetrafluoride of carbon.

NOTES OF

DEMONSTRATIONS ON PHYSIOLOGICAL CHEMISTRY AT ST. GEORGE'S HOSPITAL.

By S. W. MOORE.

VII.

Blood, seen by the unaided eye, is a red fluid; when observed through a microscope of tolerably good magnifying power, appears to consist of a yellow fluid, in which may be seen floating corpuscles; these are red and white. In human blood the red corpuscle is about 1-3400th of an inch in diameter, the white about three times this size, and in proportion of 2 or 3 white to 1000 red.

The constituents of blood are albumin, fibrin (?), hematin, and globulin; oleic, stearic, lactic, phosphoric, sulphuric, and hydrochloric acids, in combination with Na, K, Ca, Mg, &c; cholesterine and phosphorised fat. The blood is so intimately connected with every change going on in the system that its composition is not the same at any two periods; the constant changes also generate heat, the degree of which may be estimated with a thermometer either at the mouth or rectum, the latter giving the better results.

Blood under certain conditions coagulates, becomes solid; the clot formed contracts, and serum separates, forming the condition known to the ancients as the "buffy coat;" this phenomenon is due to the formation of a substance called fibrin. There are several speculative theories regarding this body: the one most credited at present being that it is formed from two different elements uniting, a "fibrinoplastic" and fibrinogenous; one existing in the corpuscles, the other in the serum.

Fibrin, which has the same composition as albumin, is considered by some to be a waste product: this is very doubtful; the subject, however, is too lengthy for discussion here.

Fresh fibrin decomposes H_2O_2 with evolution of O.

Freshly drawn blood, when whipt with twigs or shaken up in a bottle with fragments of zinc, yields fibrin in a coagulated form. This coagulation may be accelerated by a temperature of more than 50° C., the electrical current, contact with air, and agitation; it may be retarded by cold, contact with living membranes, diluting with water, or mixing with such salts as Na_2SO_4, NaCl, the alkaline carbonates, and KNO_3. Fresh blood freezes at 0° C., and can be melted without perceptible change.

During respiration, the blood undergoes very important changes, the appreciable alteration being in the corpuscles, due evidently to the oxidation of their hematin.

On entering the lungs, the blood is exposed to a vast surface of air by its distribution in the capillaries; O is absorbed, and the blood assumes a bright-red colour, losing CO_2. The exhalation of CO_2 from the lungs occurs to so great an extent that it is calculated that about 8 ozs. of C are given off in twenty-four hours: we may thus look on the corpuscles as carriers of O to the various tissues for the purpose of the interchange necessary to burn up effete matters. These changes may be observed to perfection by the aid of the spectroscope.

Many gases may be respired without ill effect; others, such as CO_2 and N, cause death from the absence of O, whilst others, as H_2S, AsH_3, PH_3, HCN, CO, &c., are poisons of a very active nature.

There are several gases contained in the blood; these may be separated by the aid of the air-pump.

EXAMPLES FOR PRACTICE IN QUANTITATIVE ANALYSIS.

By ALEXIS A. JULIEN,

Assistant in Charge of the Quantitative Laboratory of the School of Mines, Columbia College.

(Concluded from p. 9).

Example No. 9.—*Determination of the Alkalies in Silicates.*

Pulverise very finely, weigh out 2 grammes, mix with 2 grms. of dry NH_4Cl, add 16 grms. of $CaCO_3$, mix intimately, transfer completely to a platinum crucible, warm gradually until fumes of ammonia salts no longer appear, and heat to full redness, but not too intensely, for 30 to 40 minutes. Cool, boil with 100 c.c. of H_2O until no lumps remain, filter, and wash thoroughly. To the filtrate add $(NH_4)_2CO_3$ in slight excess, concentrate to about 30 c.c., add a little more $(NH_4)_2CO_3$, and some $(NH_4)_2O$, filter and wash. Evaporate the filtrate in a weighed dish on the water-bath to dryness, then heat in an air-bath, and finally heat carefully almost to redness, to expel ammonia salts, cool, and weigh. Result, NaCl + KCl. If, on re-dissolving in a little water, an insoluble residue appears, separate and determine it on a very small filter.

To the solution of the alkaline chlorides add an excess of a concentrated neutral solution of $PtCl_4$, evaporate nearly to dryness on a water-bath below the boiling-point, treat the residue with alcohol (sp. gr. 0·86—0·87), cover, and allow to stand a few hours with occasional stirring, and decant upon a small filter. If the fluid is of a deep yellow colour, and no white saline particles are to be seen mixed with the yellow crystalline precipitate, a sufficient quantity of the precipitant has been added. Transfer to the filter, wash thoroughly with alcohol, dry, wrap up the filter, place in a small weighed porcelain crucible, cover, heat until the paper is completely charred, remove the cover, burn off the carbon, cool, throw in a very minute portion of pure oxalic acid, cover, and ignite, gently at first, finally to a strong red-heat, and cool. Treat with water, and wash the residuary platinum by decantation, until the last rinsings remain clear upon addition of argentic nitrate. Dry, ignite, and weigh. One equivalent of platinum represents one equivalent of potassium; and the amount of KCL is thus readily calculated.

Example No. 10.—*Analysis of Iron Ores.*

General Scheme.—Prepare an average sample for analysis (Note 1). Make a qualitative examination for Cr_2O_3, Cu, As, and Ti.

The ore generally contains Ca, Mg, Al, Fe, Mn, S, P, H_2O, SiO_2, and may contain Na_2O, K_2O, Cr_2O_3, Zn, Ni, Co, Cu, As, SO_3, TiO_2, V_2O_5, WO_3, CO_2, Cl, Fl, organic matter.

I. *Special Determinations.*—A. In 1 grm. determine H_2O by direct weight. B. In 1 grm. determine CO_2 by direct weight, as in example 7, B. C. For special determinations of K_2O, Na_2O, Cr_2O_3, FeO, As, S, SO_3, TiO_2, V_2O_5, WO_3, Cl, Fl, organic matter, see Appendix.

II. *Main Analysis.*—Pulverise 5 grammes to impalpable powder, and fuse thoroughly in platinum crucible (Note 2) with 20 grms. Na_2CO_3 (increasing to 30 grms. as the ore contains more SiO_2 and silicates) and 2 grms. $NaNO_3$ (increasing to 5 grms. as the ore contains more FeO, sulphides, or organic matter). After cooling, treat crucible and fused mass in a small beaker with boiling water, until the mass is thoroughly disintegrated (Note 3). If the solution has a *decided* green colour, digest with a little alcohol, filter, and wash with hot water (Note 4).

1. Water Solution.—It must be perfectly clear, but may be coloured. It may contain Al_2O_3, ZnO, SiO_2, SO_3, P_2O_5, CrO_3, As_2O_5.

Add excess of HCl, evaporate to dryness (Note 5), moisten residue thoroughly with HCl, digest with hot water, filter, and wash with hot water.

Residue (*a*). SiO_2, &c., to be added to and re-fused with Residue (*b*).

Filtrate (*a*). Dilute to 500 c.c., and divide into three portions.

Solution (a^1), 300 c.c. (If the ore contains As, see Note 6). Put into a large flask (to be afterward combined with solution d^1) after determining Cr_2O_3, if present (Note 7).

Solution (a^2), 100 c.c. Add $BaCl_2$ and determine SO_3 as $BaSO_4$ (Note 8).

Solution (a^3), 100 c.c. Add to solution (d^2), as a little Fe often enters the water solution.

2. Insoluble Residue.—It may contain CaO, MgO, Al_2O_3, MnO, ZnO, NiO, CoO, Fe, As, CuO, P_2O_5, SiO_2. TiO_2 (and Pt from the crucible).

Dry the residue, transfer it to casserole, dry and burn the filter and add its ashes, moisten with H_2O, treat with HCl, evaporate to dryness, and add HCl (Note 9). Warm and digest with hot water, with occasional stirring. When dissolved to a clear solution, filter and wash.

Residue (*b*). It may contain SiO_2, TiO_2, and other insoluble substances. Combine it with Residue (*a*), fuse with 5 parts Na_2CO_3, and proceed as in example No. 7, A, *a*.

Resid. (*c*). Dry, ignite, and weigh in platinum crucible. Weight = SiO_2 + TiO_2. Expel SiO_2 with dilute H_2SO_4 & NH_4Fl. If residue is soluble, dissolve and add to Filt. (*b*). If not, determine the TiO_2 Note 10).

Filt. (*c*). Add this filtrate and washings to Filt. (*b*).

Filtrate (*b*), *or Hydrochloric Solution.* Combine with Filtrate (*c*). Saturate thoroughly with H_2S gas.

Precipitate (*d*) May contain Cu, As, Pt, and separated S. Boil with aqua regia, add NH_4Cl, evaporate to dryness, treat with H_2O and alcohol, filter, and wash. The precipitate contains Pt from crucible, as $2NH_4Cl$, Pt, Cl_4. Saturate filtrate with H_2S gas, filter, dry, burn filter, and put in crucible, add conc. HNO_3, dry, ignite, and weigh CuO.

Filtrate (*d*). Boil with HNO_3, dilute to 500 c.c., and divide into 3 portions.

Solution (d^1), 300 c.c. Combine with Solution (a^1) in large flask, add $(NH_4)_2CO_3$ almost to neutralisation and sodic acetate in excess, dilute very largely (Note 11), and boil.

Solution (d^2). 100 c.c. (when the ore contains TiO_2 see Note 10). Determine the Fe volumetrically (Note 18).

Sol. (d_3) 100 c.c. to be reserved for accidents.

Precipitate (*e*) May contain Fe_2O_3 and Al_2O_3 (as basic acetates) and perhaps P_2O_5 and TiO_2. Dissolve in HCl, and divide into 2 portions.

Sol. (e^1). Remove all HCl, add HNO_3 in large excess, and determine P_2O_5 as in example No. 7, C, *b*, (Note 12).

Solution (e^2). Boil with a little $KClO_3$, and add $(NH_4)O$ in excess, and $(NH_4)_2CO_3$, to precipitate $Fe_2O_3+Al_2O_3+P_2O_5(+TiO_2)$. Boil till all free NH_3 is expelled, filter and wash thoroughly, &c. (Note 13). From this weight deduct P_2O_5 found in e^1 and Fe_2O_3 calculated from d^2, and difference = $Al_2O_3(+TiO_2)$. If TiO_2 is present, determine this part and the Fe as in Note 10.

Filtrate (*e*) May contain Mn, Zn, Co, Ni, Ca, Mg. Concentrate to small bulk, transfer to flask, add $NH_4Cl+(NH_4)_2O$ to alkaline reaction and $(NH_4)_2S$ until odour is decided. Fill flask with water, and set aside over night (Note 14).

Precipitate (*f*) May contain Mn, Zn, Co, and Ni (as sulphides). Dissolve on the filter with very dilute HCl, and wash.

Residue (*g*) May contain Ni and Co as sulphides. Combine with Precipitate (*h*). Transfer to crucible, add conc. HNO_3 and H_2SO_4, digest, evaporate, dry, ignite, and weigh as sulphates. (Note 15).

Solution (*g*) May contain Zn and Mn. Boil, add Na_2CO_3 in excess, filter, and wash (Note 16). Dry precipitate, and ignite strongly to constant weight. Then dissolve in HCl, add sodic acetate, and saturate with H_2S gas. Filter, wash, dry, ignite in platinum crucible, at first gently, then intensely, adding a little $(NH_4)_2CO_3$. Deduct this weight from the former, and difference = Mn as Mn_3O_4.

Filtrate (*f*) May contain CaO and MgO. Acidulate with acetic acid, boil and filter. (Note 17).

Precipitate (*h*). Combine with Residue (*g*).

Filtrate (*h*). Precipitate CaO as CaC_2O_4 and MgO as $MgNH_4PO_4.6H_2O$.

NOTES.

NOTE 1. *Sampling the Ore.*—Break up in an iron mortar 40 or 50 lbs. into pieces that will pass through a tin sieve with ½-inch holes. Thoroughly mix the fine and coarse. Break up about 10 lbs. of average quality, so that it will pass through a tin sieve with ½-inch holes. Mix well, take 1 lb., and pulverise in iron mortar until it will pass through brass sieve of 60 meshes to the linear inch. Mix well, take out about 30 grammes, pulverise in iron mortar, pass through muslin bolting-cloth, and put into a small bottle, tightly corked, for analysis and special determinations. It is yet necessary that every portion of this, required for the main analysis or a special determination, should be further pulverised, as needed, in the agate mortar, to an *impalpable powder*.

NOTE 2. *Preliminary Fusion.*—Thoroughly mix the ore and its fluxes on glazed paper, put about a third of the mixture in a 2-oz. platinum crucible, the lower portion of whose interior surface has been previously lined with a thin layer of Na_2CO_3, and heat over a common Bunsen burner, with a strong flame, until the greatest violence of the effervescence has ceased. Then add and treat the two-thirds remaining successively, and with the same precaution. Finally, heat strongly over the blast-lamp until the mass is in complete and quiet fusion, adding a little more Na_2CO_3, should it not readily fuse.

NOTE 3. *Removal of the Fused Mass.*—Let the crucible cool until just below red-heat, and place it on a clean and dry iron plate, whose lower part is immersed in cold water. When the crucible is cool enough to hold in the hand, put it into the smallest beaker in which it can lie upon its side, and digest with boiling water. The fused mass will generally soon become detached from the crucible, and come out in a cake. Then remove the crucible, wash it, treat in a small beaker with a little conc. HCl, to remove any adhering particles of the mass, and add this solution to that of the Insoluble Residue (2). Should any portion of the fused mass, thicker than a film, obstinately resist solution in the hot water, it must be removed only by patience and long boiling; and no attempt should be made either to *dig* it out or to dissolve it in HCl, lest by the formation of aqua regia or free Cl (in presence of the $NaNO_3$ or Mn_2O_3) the crucible may be attacked and injured.

NOTE 4. *Reduction of* H_2MnO_4.—If alcohol is added to the solution, heat on the water-bath, to avoid any risk of breaking the beaker by the bumping of the residue in the boiling solution. If there was no bluish-green tint in the fused mass, nor decided green colour in its solution, it is unnecessary to add alcohol.

NOTE 5. *Separation of* SiO_2.—In order to render the SiO_2 entirely insoluble, the evaporation should be carried to perfect dryness, until no odours of HCl can any longer be detected, and the mass is hard and crumbly. As the residue is to be re-fused with Residue (*b*), the drying may be completed at a temperature somewhat higher than 100° C.

NOTE 6. *Removal of* As.—The As has already been mostly or completely volatilised in the foregoing evaporation. If a trace is still suspected to remain, either repeat the evaporation with HCl or else employ the following method:—Saturate with H_2S gas, filter, wash, add a little $KClO_3$ to the filtrate, and boil until the S is completely oxidised.

Note 7. *Determination of* Cr_2O_3.—In order to oxidise all the Cr_2O_3 in the solution, either of the following methods may be employed :—

(*j*). Add Na_2CO_3 almost to neutralisation, and then sodic acetate in excess. Pass Cl or add Br. to saturation. Boil gently, keeping solution almost neutral by occasional additions of Na_2CO_3, until all excess of Cl or Br is expelled.

(*k*). Add pure KHO in excess, and boil with sufficient Br. Cool, add HNO_3 almost to neutralisation, acidulate with acetic acid, add sodic acetate in excess, and boil.

Filter out hot the basic aluminic acetate precipitated as above, and wash with hot H_2O containing a little sodic acetate. To filtrate add baric acetate in slight excess, filter, and wash. This last filtrate and the precipitate of aluminic acetate contain all the P_2O_5 and Al_2O_3 in the Water Solution. The latter is to be dissolved in HCl, the former to be freed from the excess of baric acetate with dilute H_2SO_4, and both to be added to Solution (*d*[1]).

Digest the precipitate of $BaCrO_4$ and $BaSO_4$ with conc. H_2SO_4, boil, filter, and wash. Then adopt either of the following methods :—

(*l*). Boil the filtrate with conc. HCl and alcohol, to reduce CrH_2O_4 to Cr_2O_3, and precipitate the latter with $(NH_4)_2O$.

(*m*). Add $(NH_4)_2O$ in excess, pass H_2S gas until saturation, keeping the liquid near the boiling-point. When Cr_2O_3 is completely precipitated, filter, wash thoroughly with hot water, dry, &c.

Note 8. *Precipitation of* $BaSO_4$.—Avoid the addition of a large excess of $BaCl_2$ solution. Add only 5 c.c. at first, and then, after complete subsidence of precipitate, add a few drops to determine if any H_2SO_4 remains unprecipitated, &c. Then proceed as in Example No. 2, B.

Note 9. *Separation of* SiO_2.—Evaporate as in Note 5. Then add HCl pretty freely, and warm for some time before adding any water, as the high heat may have produced anhydrous Fe_2O_3, forming an oxychloride which is very slow to dissolve, especially in dilute acid. Should the acid already added be too dilute, concentrate by evaporation, add conc. HCl, and digest at a moderate heat.

Note 10. *Determination of* TiO_2.—After weighing the precipitate, ignite it *strongly* in H gas to reduce the Fe_2O_3, cool, dissolve out all the metallic Fe by boiling with dilute H_2SO_4, filter, wash, dry, ignite, and weigh in platinum crucible ($TiO_2+Al_2O_3$). In the filtrate determine the Fe volumetrically (Note 18). Fuse the residue with about six parts of $KHSO_4$, in which it will readily dissolve. Cool, take up the fused cake in *cold* water, filter if necessary, add one or two drops of dilute HNO_3, and precipitate the TiO_2 in the very dilute solution by long boiling (usually six to eight hours). Filter, wash with acidulated water, dry, and ignite. Should the ignited TiO_2 be coloured by FeO_2, repeat the process. When there is much TiO_2 in the ore, a special determination should be made (see Appendix) ; or the percentage found as above should be added to that of the part found in (*e*[2]) by treating that precipitate in exactly the same way.

Note 11. *Precipitation of the Basic Acetates.*—Dilute the solution to about 1 litre for each gramme of the sesquioxides present. It is sufficient to boil from 10 to 15 minutes for the complete precipitation of the acetates. The filtering should be done rapidly on a ribbed filter, keeping the fluid hot, and disturbing the settled precipitate as little as possible. After the supernatant fluid has been poured through the filter, throw on the precipitate, and wash it with boiling water containing a little sodic acetate. Should any basic acetate separate upon concentrating the filtrate, add some sodic acetate, boil, filter, dissolve the precipitate in HCl, and unite to the solution of the main body.

Note 12. *Determination of* P_2O_5.—The removal of HCl may be effected by evaporating the solution with a large excess of HNO_3, until a glass rod, moistened with $AgNO_3$ and held over the surface of the liquid, is no longer clouded by the escaping vapours. Or still better, in some hands, add $(NH_4)_2O$ suddenly in large excess, filter, wash once, and re-dissolve in boiling HNO_3.

Note 13. *Determination of* Al_2O_3.—It is generally more accurate to determine the Al_2O_3 directly in this precipitate, as follows :—Dissolve by long boiling in a flask with conc. HCl, remove from the flame, reduce the Fe_2O_3 by Na_2SO_3. Boil some time, neutralise with Na_2CO_3, add solution of *pure* KHO or NaHO in excess, boil some time, allow to settle, decant the clear liquid through a filter, boil again with KHO, decant, and wash, first by decantation, afterwards on the filter with hot water. Acidify the filtrate with HCl, boil with a little $KClO_3$, concentrate, and precipitate the Al_2O_3 (+TiO_2, if present) with $(NH_4)_2O$. Other methods are given by A. Frönde. (*Zeits. für An. Chem.*, 1866, 395).

Note 14. *Precipitation of the Sulphides.*—Add no more of the yellow sulphide of ammonium than is required, as an excess will re-dissolve a portion of the precipitate unless much NH_4Cl be present. But an excess of the latter reagent will interfere with the concentration necessary to precipitate the MgO in Filtrate (*h*). Cork the flask tightly before setting it aside.

Note 15. *Separation of* Co *and* Ni.—Should these constituents be present in considerable quantity, which very rarely happens, it is better, as the nickelic sulphate is likely to be partially converted into NiO strong ignition, to dissolve the sulphides in aqua regia, neutralise with KHO, precipitate and determine the CoO by Genth and Gibbs's process, and in the filtrate determine the Ni as oxide.

Note 16. *Determination of* Mn.—(Gibbs's process. *Am. Journ. Sci.*, xliv., p. 216). To the HCl solution, free from H_2S, add $(NH_4)_2O$ in excess, and solution of Na_2HPO_4 in large excess. Then add dilute H_2SO_4 or HCl until the white precipitate re-dissolves, heat to boiling, and add $(NH_4)_2O$ in excess. Digest near the boiling-point about an hour, when the precipitate, at first white and gelatinous, becomes crystalline in rose-coloured scales. Filter, and wash with hot water. If tinged red, re-dissolve the precipitate in dilute HCl, and repeat the process. On ignition the precipitate is converted into $Mn_2P_2O_7$, a nearly white powder. If Zn is present, it must first be separated as ZnS, as in the scheme.

Note 17. *Precipitation of Dissolved* NiS.—A trace of NiS, which is somewhat soluble in sulphide of ammonium, is often carried through into this filtrate, but is completely thrown down, along with the excess of S, by this acidulation.

Note 18. *Volumetric Determination of* Fe.—Put Solution (*d*[2]) directly into a flask holding 200 c.c., cool, dilute with cold water exactly up to the mark, mix by pouring back and forth several times from the flask to a beaker, draw out 100 c.c. with a pipette known to *deliver* that quantity, empty it into one reduction bottle, and into another empty the flask, and rinse out the flask, beaker, and pipette. The reduction bottle consists of a wide-mouthed bottle, holding about 250 c.c., with its lip ground down perfectly smooth, and covered by a ground-glass plate loosely held to its place by wires. Carefully let down in each bottle a lump of amalgamated zinc, free from Fe, and a strip of platinum foil resting upon it, add about 10 c.c. of conc. H_2SO_4, cover, and set aside overnight. When the reduction is complete the solution will be colourless.

Then in each of two flasks, holding about 75 c.c., introduce exactly 0·2 gramme of fine iron wire, add an excess of dilute H_2SO_4, and immediately adjust corks (having bent tubes attached, with their ends immersed in small beakers of warm water), and heat until the complete solution of the wire. By this water-valve arrangement the entrance of air and oxidation of the $FeSO_4$ solution are avoided, and when the water begins to run back, after the evolution of H has ceased, its warmth prevents the too sudden reduction of the temperature, and condensation of the vapours in the flasks. After cooling, pour and wash out the contents of each flask, with the beaker of

water attached, into a large beaker, add dilute H_2SO_4 in excess, dilute to about 1 litre, and titrate successively and rapidly with the solution of $KMnO_4$, to determine its strength.

Now pour and wash the contents of each reduction bottle into a large beaker, add dilute H_2SO_4, dilute to about a litre, and titrate successively as before. In a HCl solution all possible excess of that acid must be avoided, and the solution must be diluted to about 2 litres. When greater accuracy is desired the HCl may be replaced, previously to the reduction, by evaporating the solution with excess of H_2SO_4.

When the ore contains TiO_2 the process given in Note 10 must precede this determination, because any TiO_2 present in the solutions put in the reduction bottles would be reduced (yielding a pink tinge), as well as the Fe_2O_3, and consume a portion of the $KMnO_4$ in its re-oxidation.

Another method has been recently published (*American Chemist*, July, 1870, p. 23), by which the previous reduction of the iron is not required, and a solution of $CuCl_4$ is employed for titration, but its accuracy has not yet been confirmed.

Appendix.—Special Determinations.

Alkalies.—Weigh out 5 grms., and determine as in Example No. 9.

Chromium.—Fuse, &c., as in Main Analysis, obtain Filtrate (*a*) of the Water Solution, and determine the Cr as in Note 7. But if the ore be chromic iron, either of the four following methods may be employed for its decomposition, after it has been pulverised to an impalpable powder. Little is known in regard to their comparative accuracy and convenience, especially of the last two.

(*a*). Hunt's Method.—Mix 0·5 grm. of ore with 6 grms. $KHSO_4$ in a large platinum crucible, fuse for 15 minutes at a temperature scarcely above the fusing-point of the salt, and then raise the heat somewhat, so that the bottom of the crucible may just appear red, and keep it so for 15 to 20 minutes. The fusing mass should not rise higher than half-way up the crucible. Then heat until the fumes of H_2SO_4 no longer escape. Now add 3 grms. Na_2CO_3, heat to fusion for an hour at a gentle red-heat, adding 3 grms. KNO_3 in small portions from time to time, and then heat for 15 minutes to bright redness, and cool. Treat with boiling water, filter hot, wash with hot water, digest the residue with HCl, and, if anything then remains undissolved, subject it again to the above operation. To the alkaline filtrate add an excess of $(NH_4)_2NO_3$ in excess, evaporate on a water-bath nearly to dryness, and until all free ammonia is expelled, filter, and wash. The CrO_3 is determined in this solution.

(*b*). Gibbs's Method (*Am. Journ. Sci.*, II., xxxix., p. 59).—Fuse over blast-lamp with 10 to 15 parts KF, HF, digest with H_2SO_4 until F is expelled, add hot water, and filter.

(*c*). Britton's Method (*Journ. Frank. Inst.*, March, 1870).—Weigh 0·5 grm., mix with 4 grms. of the flux (1 part $KClO_3$+3 parts soda-lime), ignite in a platinum crucible at a bright red-heat for over 1½ hours, cool, triturate the sintered mass in a porcelain mortar, digest in a 4 oz. beaker with 18 c.c. of hot water, boil for 2 or 3 minutes, cool, add 15 c.c. of HCl, and stir for a few minutes until solution. Pour into a known quantity of solution of $FeSO_4$, and determine volumetrically the amount of iron which remains unoxidised by the CrO_3.

(*d*). Pearson's Method (*Am. Journ. Sci.*, Sept., 1870).—Place 0·5 grm. of ore in an evaporating dish, add sufficient conc. HNO_3 to cover it, add a little $KClO_3$, cover with an inverted funnel, and digest, adding small quantities of $KClO_3$ from time to time, until the ore is thoroughly decomposed. Dilute, filter, and wash. Dry the residue, fuse it with a mixture of Na_2CO_3 and KNO_3, cool, dissolve in hot water, and test the solution for Cr. If none is found, the entire amount will be found in the above filtrate.

Ferrous Oxide.—Digest 1 grm. of ore, finely pulverised, in a flask with conc. HCl, passing a current of carbonic anhydride. After complete decomposition, cool in carbonic anhydride, and immediately titrate the solution of $FeCl_2$, without removing the insoluble residue, with $KMnO_4$ (Note 18). The presence of organic matter and of the higher oxides of Mn will interfere with the accuracy of the process.

For a special determination of the entire amount of Fe in an ore, either this method may be employed, omitting the use of carbonic anhydride, and reducing by Zn, as in Note 18; or the ore may be decomposed by fusion, as in the Main Analysis, without the use of Na_2NO_3; or, in the case of chromic iron, either of the above-mentioned four methods may be used; or Clarke's method may be employed, as follows (*Am. Journ. Sci.*, xlv., 178):—Thoroughly mix 1 grm. of ore with 3 grms. of NaF or pure powdered cryolite, put in a large platinum crucible, and cover with 12 grms. of coarsely powdered $KHSO_4$. Fuse about 20 minutes, cool, add conc. H_2SO_4, fuse to homogeneous paste, cool, and dissolve in cold water. When cryolite is used, a bulky white residue of $CaSO_4$ generally remains. Reduce the solution obtained by either of these methods, and titrate in usual way. But if the ore contains TiO_2, see Notes 10 and 18.

Arsenic.—Fuse 5 grms. of ore as in Main Analysis, and obtain the Water Solution, in which the As will be present as sodic arseniate. Add a little Na_2SO_4 and HCl to slight acid reaction, boil a few minutes until all the As_2O_5 has been reduced to As_2O_3, saturate the warm solution with H_2S gas, filter, and wash with H_2S water. Dry filter and contents, and oxidise them in a beaker with fuming HNO_3. Dilute, warm gently with a little $KClO_3$, to oxidise organic matter.

Sulphuric Acid.—Boil 5 grms. ore with 50 c.c. HCl+50 c.c. H_2O+10 c.c. alcohol. Filter and precipitate with $BaCl_2$ in the filtrate. The difference between the sulphuric anhydride thus found and the total found in the Main Analysis will give the amount equivalent to the S actually existing in the ore as metallic sulphide.

Titanic Acid.—The ore must be decomposed, and the TiO_2 brought into solution in cold water by Clarke's method, described under "Ferrous Oxide." Then proceed as in Note 10.

Vanadic and Tungstic Acids.—These acids, which occur in very small quantities in some European ores, may be separated and detected as follows:—Treat Residue (*a*), obtained from 10 to 20 grms. of ore, like Residue (*c*) in the Scheme, until all SiO_2 is expelled. Any residue which remains may contain Al_2O_3, TiO_2, V_2O_5, and WO_3. Ignite and weigh, fuse it with Na_2CO_3, dissolve in HCl, boil, add $(NH_4)_2O$ in excess, and saturate with H_2S gas. A red colour will denote the presence of V_2O_5, and a brown precipitate that of WO_3 (*Pogg. Annal.*, 21, 47. *H. Rose's Handb. d. Anal. Chem.*, ii., 764).

Chlorine.—This occurs in ores containing apatite. Mix with Na_2CO_3 and K_2CO_3, moisten with water, dry in the platinum crucible, fuse, boil with water, remove the dissolved SiO_2 by means of $(NH_4)_2CO_3$, and then precipitate, after addition of HNO_3, with $AgNO_3$.

Fluorine.—This occurs in ores containing apatite and fluor-spar. Decompose the ore by Berzelius's method, separate the SiO_2, and expel the excess of $(NH_4)_2CO_3$. If P_2O_5 is present, precipitate with $CaCl_2$, together with CO_2 and HFl, and separate the $CaCO_3$ by acetic acid. In the remaining precipitate of $Ca_3P_2O_8+CaFl_2$, determine the Fl directly by Wöhler's method, as $SiFl_2$.

Organic Matter.—Roast 1 grm. in an open crucible, at a red-heat, and (when the protoxide of iron, the higher oxides of manganese, sulphur, and arsenic, are absent) the *loss* diminished by the amounts of carbonic anhydride and H_2O present will be approximately equivalent to the amount of organic matter.

ON THE

CHEMICAL CONSTITUTION OF GLYCOLIC ALCOHOL AND ITS HETEROLOGUES,

AS VIEWED IN THE NEW LIGHT OF THE "TYPO-NUCLEUS" THEORY.*

By OTTO RICHTER, Ph.D.

(Continued from p. 280).

THE chemical constitution of glycolic alcohol and its heterologues may be adequately expressed by means of the following table of rational formulæ, where the non-essential constituents are separated from the essential constituents by a horizontal line. You will also understand that the various marks of punctuation used in these formulæ are typical symbols of molecular grouping. Thus, a dot connects the base with its acid; a semicolon connects the hydrocarbon adjunct with its principal; an inverted semicolon connects the halogen† adjunct with its principal, and a concave curve connects two principal bases with one another. I must further say that for want of a proper nomenclature, it has here and there been found necessary to introduce new names.

Table of Chemical Formulæ Representing the Chemical Constitution of Glycolic Alcohol and its Heterologues.

$H_{12}C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2H_2C_2;H_2O_2}$
Glycolic alcohol	
$H_8C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2C_2;H_2O_2}$
Deglycolic alcohol..	
$H_8C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2H;2C_2O}$
Glycolite of water	
$H_8C_8O_{12}$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2H;2C_2O_3}$
Glycolate of water..	
$H_8C_8O_{16}$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2H;2C_2O_5}$
Oxyglycolate of water	

So far as I am aware, the glycolic alcohol, which is the parent molecule of this family group, has not yet been obtained in a state of isolation. The well-known ethylen-glycol might at first sight be taken for the missing alcohol, more particularly when we couple the decidedly biatomic character of their respective molecules with the other and even more significant fact that the whole of the glycolic heterologues may be produced by the simple oxidation of the ethylen-glycol. Nevertheless, and notwithstanding these striking points of resemblance, I am inclined to believe that these two alcohols are not alcohol, but only isomeric, and I ground my belief upon the occurrence of a certain class of chemical compounds among which the so-called diethyl-acetal is the most conspicuous and best investigated member. This diethyl-acetal, you will recollect, is strictly isomeric with the diethyl-ether of the ethylen-glycol, and I feel convinced that it is the missing glycolic alcohol to which we are indebted for this curious and instructive case of isomerism. A cursory examination and comparison of the subjoined rational formulæ will suffice in order to prove that my belief is well founded.

$H_{12}C_8O_8$	$\frac{H_2O_2\cdot}{2H_2C_2;H_2O_2_2C_2}\frac{H_2O_2}{;H_2O_2}$
Ethylen-glycol	
$H_{12}C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2}\frac{H_2O_2\cdot}{2H_2C_2;H_2O_2}$
Glycolic alcohol	
$H_{28}C_{24}O_8$	$\frac{2H_4C_4;H_2O_2\cdot 2H_4C_4;H_2O_2\cdot}{2H_2C_2;H_2O_2_2C_2;H_2O_2}$
Diethyl ether of ethylen-glycol	
$H_{28}C_{24}O_8$	$\frac{2H_4C_4;H_2O_2\cdot 2H_4C_4;H_2O_2\cdot}{2C_2;H_2O_2;2H_2C_2;H_2O_2}$
Diethylacetal	

You will observe that ethylen-glycol differs from glycolic alcohol in two essential points; *first*, in the former compound, the two alcoholic constituents are represented as playing the co-ordinate part of principal alcoholic bases, while in the latter compound one of these alcoholic bases is represented as playing the subordinate part of adjunct to the other base. *Secondly*, the relative positions which the two alcoholic constituents occupy in ethylen-glycol are exactly reversed in the glycolic alcohol. A mere glance at the two formulæ which express the chemical constitution of the isomeric ether derivatives will, I trust, enable the reader to complete the analysis of these hitherto obscure and unintelligible cases of isomerism. The second member in the family of glycolic heterologues is likewise very little known. I have applied to it the term "deglycolic alcohol," in order to record the fact that it is produced from the primary alcohol by the simple abstraction of two molecules of hydrogen from the methylen adjunct of the principal water base. This secondary alcohol, like the majority of the alcohols which occupy the second place in the family group of the heterologues of the fatty alcohols, seems, from its want of stability, very prone to merge into the isomeric and far more permanent modification of the glycolite of water. In this remarkable metamorphosis, the double carbon adjunct of the principal water base becomes first of all converted into an acid twin carbon nucleus, which reunites under this new form with the old water base, whereupon, under the combined influence of base and acid, the remaining water molecule becomes decomposed so as to surrender its oxygen to the envelope of the acid twin carbon nucleus, while the hydrogen connects itself with the same nucleus under the typical form of a hydrocarbon adjunct. It is worthy of note that in this singular and characteristic re-arrangement of the constituent elements, the organic molecule has, without loss of substance and without loss of saturating capacity, passed at one bound from the category of a true and genuine alcohol into the category of a true and genuine water salt. As regards the two remaining heterologues of glycolate of water and oxyglycolate of water, you cannot but see that their formation is due to the successive absorption of two molecules of oxygen by the envelope of the glycolous acid constituent, and that they differ from each other in this respect only, that the former contains for its principal constituent formate of water, while the latter contains instead of it oxyformate of water. Some of my readers may here be supposed to ask, what is oxyformate of water: Why, it is simply a highly interesting isomeric modification of the neutral carbonate of water. You are aware that on account of its excessive want of stability none of the carbonates of water can be obtained in a state of isolation. The compound before us differs from the isomeric neutral carbonate in being decidedly monobasic, while the latter is as decidedly bibasic. The cause of this apparent anomaly becomes now fully revealed, for it is plain that one of the two hydrogen molecules which, in the ordinary carbonate of water are both of them readily displaceable by metals, has assumed the hydrocarbon form of grouping, in consequence of which it will cease to play the part of a basic nucleus, and although it may become eliminated or exchanged in obedience to other modes of substitution, it is certain that the ordinary process of double decomposition has no control over it. In speaking of the deglycolic alcohol, I forgot to mention that a substance has recently been obtained by Boutlerow, and re-examined by Hofmann, who mistook it at first for the missing formic aldehyde. This curious compound, if we take the density of its vapour for our guide, ought to be represented by the same empirical formula as the deglycolic alcohol, but from its chemical deportment it will probably become identified with the glycolite of water, which I regard as the true aldehyde of the glycolic family group.

Let us now pass on to consider those interesting and singularly close chemical relations which are found to obtain between the heterologues of the glycolic alcohol on

* Abstract of a Paper read before the British Association, Edinburgh Meeting, 1871.

† You will bear in mind that in my system the term "halogen" includes every species of mono- or polynormal acids, bases, or salts; and that the empirical formulæ used in my system are exactly the double of the ordinary formulæ. $H_2=2$; $C_2=12$; $O_2=16$.

the one hand and the heterologues of the ethylic alcohol on the other hand. These two kindred family groups are in the subjoined table brought face to face with one another.

Heterologues of Glycolic Alcohol.

$H_{12}C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2:2H_2C_2;H_2O_2}$
Glycolic alcohol	
$H_8C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2:2C;H_2O_2}$
Deglycolic alcohol	
$H_8C_8O_8$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2:2H;2C_2O}$
Glycolite of water	
$H_8C_8O_{12}$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2:2H;2C_2O_3}$
Glycolate of water	
$H_8C_8O_{16}$	$\frac{H_2O_2\cdot}{2C_2;H_2O_2:2H;2C_2O_5}$
Oxyglycolate of water	

Heterologues of Ethylic Alcohol.

$H_{12}C_8O_4$	$\frac{H_2O_2\cdot}{2H_4C_4;H_2O_2}$
Ethylic alcohol	
$H_8C_8O_4$	$\frac{H_2O_2\cdot}{2H_2C_4;H_2O_2}$
De-ethylic alcohol	
$H_8C_8O_4$	$\frac{H_2O_2\cdot}{2H_3C_2;2C_2O}$
Acetite of water	
$H_8C_8O_8$	$\frac{H_2O_2\cdot}{2H_3C_2;2C_2O_3}$
Acetate of water	
$H_8C_8O_{12}$	$\frac{H_2O_2\cdot}{2H_3C_2;2C_2O_5}$
Oxyacetate of water	

You will observe, firstly, that the members thus placed opposite each other differ throughout by the constant quantity of two molecules of oxygen. You will find, moreover, that the acetate of water is isomeric with the glycolite of water and the oxyacetate of water isomeric with the glycolate of water. Now, it is an established fact, that ethylic alcohol may, under favourable conditions, become oxidised into the ethylen-glycol, or possibly, in the first instance, into the glycolic alcohol; but whichever way we take it, the fact remains, and the explanation is easy. In ordinary circumstances, namely, when by the removal of two hydrogen molecules from the ethylen adjunct, the ethylic-alcohol becomes converted into the de-ethylic alcohol, the two molecules of water, which are generated in this process will simply be eliminated from the system, whereas, in extraordinary circumstances, these two molecules of water, instead of being eliminated, will appropriate to themselves two carbon molecules from the residual acetylen adjunct, whereupon the resulting methylic and formylic alcohols will instantly combine under the one or the other form of biatomic grouping. As regards the isomeric relations of acetate and glycolite of water, on the one hand, and of oxyacetate and glycolate of water on the other hand, there cannot be the slightest doubt that these isomeric cympounds are mutually convertible, and it is clear, that when the acetate merges into the glycolate, two oxygen molecules of the oxalic acid constituent will unite, in the first instance, with two hydrogen molecules of the methyl adjunct so as to produce two molecules of water; these latter will then combine with the two molecules of carbon which are ceded to them by the residual formyl adjunct, and lastly, the generated formyl alcohol will connect itself as halogen adjunct with the acid twin nucleus of the residual formite of water. This explanation applies with equal facility to the conversion of oxyacetate of water into glycolate of water. The details of this process, as well as of the reverse process, whereby the glycolic heterologues remerge into the corresponding acetic heterologues, I shall leave the hearer to work out for himself. Let us now direct our attention to another highly instructive variety of isomeric changes which the acetic water salts are apt to experience after one or two of the methylic hydrogen molecules have been displaced by chlorine, bromine, or iodine. I shall illustrate these analogous cases by means of the bromo- and bibromo-acetates of water. The bromo-acetate has the rational formula $\frac{H_2O_2\cdot}{2H_2C_2Br;2C_2O_3}$ and it is plain that the successive phases of the process will be as follows:—One hydrogen molecule will disengage itself from the brom-methyl adjunct, become converted into an acid nucleus, and brominised; the newly formed bromide of hydrogen will then unite with the two carbon molecules which it has acquired from the residual formyl adjunct, and in the last phase of the process the resulting bromide of formyl will unite as halogen adjunct with the acid twin nucleus of the residual formate of water. Accordingly, the end product of the reaction will be bromo-glycolite of water with the rational formula—

$$\frac{H_2O_2\cdot}{2B_2;H_2Br_2:2H;2C_2O_3}$$

This compound is, therefore, isomeric with its parent bromo-acetate of water.

The bibromo-acetate of water has the rational formula $\frac{H_2O_2\cdot}{2HC_2Br_2;2C_2O_3}$ and the reaction takes the same course precisely. Hence we ought to obtain as final product, the bibromo-glycolite of water with the rational formula $\frac{H_2O_2\cdot}{2C_2;H_2Br_2:2Br;2C_2O_3}$ This compound is, therefore, isomeric with its parent bibromo-acetate of water. From its want of stability it becomes, however, readily decomposed into bromide of hydrogen and bromo-glycolid with the rational formula $\frac{}{2C_2;H_2Br_2:2C_2O_4}$. When this bromo-glycolid is in its turn subjected to successive treatment with strong bases and acids, it will give rise in the first instance to the bromoglycolate of water with the rational formula $\frac{H_2O_2\cdot}{2C_2;H_2Br_2:2H;2C_2O_5}$. and in the second instance to the oxyglycolate of water with the rational formula $\frac{H_2O_2\cdot\quad H_2O_2\cdot}{2C_2;H_2O_2:2H;2C_2O_5}$.

DECAY OF STONE AND BRICK.

By JOHN C. DRAPER,
Professor of Chemistry, University Medical College, New York.

THE rapid disintegration or decay of the brown stone, so generally employed in the construction of New York houses, leads naturally to the consideration of the causes producing this decay, and also to the examination of other building materials, and the discussion of their merits or demerits as compared with brown stone.

The chief causes of disintegration of stone and brick are:—

(1). Roughness of surface, favouring the deposition of dust.

(2). Vegetable growths, favoured by dust and moisture.

(3). Percolation of water through interstices and fissures.

(4). Action of frost.

(5). Action of acid vapours in the air.

In the experiments we propose to relate, the materials employed were the same as those mentioned in a previous paper, namely, brown stone, Nova Scotia stone, red brick, and white brick. Submitting these to a microscopic examination under a power of 25 or 30 diameters, a very instructive lesson regarding the structure of these materials is obtained. The stone is seen to be composed of various sized particles loosely aggregated together, and presenting a very rough surface; the red brick is smooth,

the fracture showing interstices of considerable size, while the white brick is not only smooth, but also dense, the interstices being very small; and every here and there minute spheres of molten glassy material are discoverable, showing the intense heat to which the brick has been subjected. Such a microscopic examination affords, to the architect and engineer, indications regarding the probable weathering power, which should never be overlooked in the selection of building material to be used in exposed locations, for the rough imperfectly cemented material not only favours the deposition of dust, which, being chiefly organic, furnishes a suitable nidus for vegetable growths, but it is also, by virtue of its structure, more friable, and, therefore, easily disintegrated by the forces to be considered hereafter.

The vegetable growth, of which we have spoken above, is a minute lichen, known as *Lepra antiquitatis*, and it grows with remarkable freedom on such hygroscopic rocks as the sandstones, as any one may satisfy himself on examining the houses on the cross, or east and west, streets of New York.

The percolation or passage of water takes place even in the densest rocks, as trap and basalt, for, in the interior of even the most compact specimens of these rocks, spots of moisture are often found on breaking them, and Bischoff states that these are always connected with minute fissures, the edges of which often show effervescence when they are touched with acid, thereby demonstrating that water may convey into, or produce carbonates, even in these dense rocks, and thereby alter their structure. This being the case with compact rock, we can form some idea of the manner in which percolating water acts on such loosely cemented material as the different kinds of sandstone.

Of the agents engaged in the disintegration of rock, one of the most efficient is frost. In its action, two elements are involved, namely the friability of the material and its hygroscopic power. The difficulty attending the direct application of cold in the examination of the action of frost, has led to the use of other and similar means. Among these none is better adopted for the purpose in view than that of dipping the material to be examined in a saturated solution of sulphate of soda, and allowing the salt to crystallise when the specimen has been thoroughly saturated with the saline solution. The crystallisation of the sulphate of soda, on and in that substance, brings to bear upon its particles the same kind of force as that produced in the crystallisation or freezing of water, and particles are torn off or separated exactly as in the latter operation. In employing this test I soaked the rock in the solution for about four hours, and let it dry and crystallise for twenty hours. The loosened material was washed off by a fine jet of water from a washing bottle, the sample re-dipped for four hours, and again set to crystallise. This was repeated eight times, the experiment extending over a period of eight days, with the following results:—

Table I.

Brown stone	10,000 parts	lost	191	of substance.
Nova Scotia stone ..	,,	,,	441	,,
Red brick	,,	,,	74	,,
White brick	,,	,,	24	,,

The disintegration is very nearly in the ratio of 1 for the white brick, 3 for the red, 8 for the brown stone, and 18 for the Nova Scotia stone, a result which furnishes information of the greatest value from an economic point of view, and which cannot be too strongly insisted upon in a country where so little attention is paid to the durability of public and private edifices.

The long periods of time required for the performance of the crystallisation test, led me to make a series of experiments to find a quicker method of arriving at a reliable determination of the friability of these substances. The plan I endeavoured to apply was to heat the specimens to a temperature of about 600° F., and then quench them while hot in cold water. The sudden chill and formation of steam on the surface of the masses caused them to disintegrate superficially, the amount of material removed after the repetitions of the chill being—

Table II.

Brown stone	10,000 parts	lost	202	of substance.
Nova Scotia stone ..	,,	,,	597	,,
Red brick	,,	,,	82	,,
White brick	,,	,,	43	,,

Which gives a ratio of 1 for the white brick, 2 for the red, 5 for the brown stone, and 14 for the Nova Scotia. These results do not agree exactly with those given by the sulphate of soda test, but they approach them more closely than could have been expected considering the different character of the force applied.

Though the chilling test described above may be objected to as not meeting the conditions prevailing during the action of frost, but being rather the opposite, on account of the employment of heat in place of cold, it gives results which are very significant when viewed in relation to the power of brick and stone to resist the destroying action of great conflagrations. The conditions of the experiment are almost identical with those presented by a building on fire, for in each case the substance is alternately heated by the flames and chilled by the water thrown to quench them. The table, therefore, gives a very fair estimate of the relative powers of the materials in question to resist such destructive action.

The chemical ingredients of the air that act on building materials are carbonic, nitric, sulphuric, and sulphurous acids. The first of these is always present as the product of combustion, and, when dissolved in rain-water, forms a solution which readily dissolves marble and other limestones, and even acts on dense granite and other rocks. Sulphuric and sulphurous acids are both found in appreciable quantity in the air of all localities where coal is used as fuel. Nitric acid is, in its turn, at times an ingredient of the air, especially after great displays of lightning; it also is produced, under certain conditions, during the decomposition of organic matter containing nitrogen. To determine the action of these acids on the materials with which I was experimenting, I placed portions of them in dilute nitric acid, and left them in contact with the liquid for two weeks. I then kept them in water for ten days, changing the water every day to ensure the removal of all soluble material; they were then dried, and being weighed, gave the following results:—

Table III.

Brown stone	10,000 parts	lost	214	of substance
Nova Scotia stone ..	,,	,,	66	,,
Red brick	,,	,,	33	,,
White brick	,,	,,	7	,,

In which the ratio of disintegration is 1 for the white brick, 5 for the red, 9 for the Nova Scotia stone, and 30 for the brown stone. From this it would appear that the reason the brown stone disintegrates so rapidly in New York is its greater susceptibility to the action of the acid products of organic decomposition and combustion, where the cementing material is dissolved or weakened, and pores and fissures in the rock being opened, it is less able to resist the attack of frost. The Nova Scotia stone, on the contrary, is a more friable material than the brown stone; yet being less acted upon by the acid waters, it resists the process of decay better. The superiority of the white over the red brick, in this respect, is even more marked than under the other tests, and, taken with them, gives unquestionable evidence of the weather-resisting power of this hard-burned compact brick.—*Scientific American.*

A REACTION OF PHENOL.

By C. CRUMP.

IF a current of ordinary coal-gas be passed into a flask containing a mixture of equal parts of phenol and strong sulphuric acid, the liquid soon becomes coloured and thick, so that unless the flask be gently heated, the passage of the gas is interrupted. After a few hours, if the contents of the flask be poured into water, a red colouring matter is obtained insoluble in water, soluble in alcohol and in alkaline solutions, its colour being changed by the latter to blue or green. The formation of the colour is not prevented by previously passing the gas through dilute sulphuric acid, solution of caustic potash, or of cupreous chloride either in hydrochloric acid or ammonia, nor does the colour seem to be produced by passing any of the ordinary constituents of coal-gas into the mixture. A similar substance, however, seems to be formed by digesting the mixture of phenol and sulphuric acid for some time at a gentle heat with two or three times its volume of commercial benzol.

PROCEEDINGS OF SOCIETIES.

ROYAL DUBLIN SOCIETY.

AT the evening Scientific Meeting of the Society, held on the 18th, Professor R. BALL delivered a discourse on the "*Conservation of Energy*," illustrated by experiments. These discourses, to which ladies have been admitted, have proved most successful. The lecturer treated his extensive and difficult subject in an able, and at the same time popular, form. He divided his discourse into five parts. 1. The different forms of energy and their mutual convertibility. 2. The indestructibility of energy. 3. The conservation of energy. 4. The distribution of energy throughout the universe. 5. The dissipitation of energy.

At the conclusion of the lecture Professor Ball spoke in eulogistic terms of Sir Wm. Thomson's finite theories of the universe. In mentioning the names of those connected with his subject, the lecturer omitted, evidently by an oversight, the names of Grove and Mayer. To these illustrious names are due the first speculations as regards the connection of the various forms of energy.

The experiments were frequently novel, and were in every case perfectly successful.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, November 27, 1871.

This number contains the following original papers and memoirs relating to chemistry and allied sciences:—

Optical and Crystallographical Observations on the Montebrasite and the Amblygonite of Montebras (Creuse).—Dr. Des Cloizeaux.—An exhaustive essay, illustrated by engravings.

Thermal Researches on Electrolysis.—P. A. Favre.—The continuation of the author's experiments.

Three Enormously Large Meteorites.—M. le Ministre de l'Instruction Publique.—The author states that he has received from the French Consul at Elseneur (Danemark) a letter communicating the arrival at Copenhagen of the two Swedish men-of-war sent to Groenland, there to take on board three very large meteorites discovered in that country by the Swedish *savant* Nordenskiold last year. By arrangement with the Danish Government, the Government of Sweden equipped the vessels to convey the meteorites to Europe. Two of these masses, weighing respectively 49,600 and 10,000 lbs, have been sent to Stockholm, while the third, weighing 20,000 lbs., has been presented to the museum at Copenhagen. The ponderous masses surpass in weight and size any meteorites yet found, excepting that the San Gregorio meteorite of the Mexican desert exceeds in weight and, in all probability, in size, the least weighty of the masses alluded to.

Separation of Potassa from Soda.—Th. Schlœsing.—The contents of this paper will be translated in our columns.

New Observations on the Alternating Predominance of Nitrous and Nitric Acid in Rain-Water.—Dr. Chabrier.—The main gist of this paper is that, during calm weather and a cloudy sky, rain-water usually contains nitrous acid, while, during storms and violent commotions of the atmosphere, nitric acid prevails.

Experimental Researches on the Properties of the So-Called Drying Oils.—Dr. Sacc.—The contents of this paper agree mainly with the exhaustive researches made several years ago by G. J. Mulder, and published in a separate volume in the Dutch language. An excellent abstract of these researches is published in *Jahresbericht über die Fortschritte der Reinen, Pharmaceutischen, und Technischen Chemie* for 1865, pp. 323 to 326.

Some Facts Relating to the History of the Phenols.—Drs. Dusart and Ch. Bardy.—The authors communicate the results of a series of experiments made with the view to prove that the class of bodies termed phenols and their compounds resemble in their chemical character some of the hydrocarbons they are derived from, and also, though with less strong affinity, the character of alcohols with which, if they are mixed, they form, under the influence of acids for instance, double ethers, which appear to be identical with those formed by the distillation of salycilates, and discovered by Professor Cahours.

Musical Sounds Produced by the Opening of the Safety-Valve Fitted to Air-Balloons while Ascending in the Atmosphere.—W. de Fonvielle.

Journal für Gasbeleuchtung und Wasserversorgung, No. 21, 1871.

In addition to a series of original papers relating to gas- and water-works' engineering and management, this number contains—

The Description of an Apparatus for So-Called Cold Gas Manufacture.—Dr. N. H. Schilling.—The author illustrates by a woodcut an apparatus essentially contrived for the preparation of hydrogen by the aid of iron and sulphuric acid, the gas being next forced through gasoline, and thus rendered luminous. It appears that in America, viz., the United States and the Brazilian Empire, this mode of obtaining gaslight is used in some localities, but is, after all, an expensive and by no means complete substitute for coal-gas. Dr. Philipp's carboxygen illumination is found superior and also less costly.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 17, 1871.

This number contains the following original papers and memoirs:—

Silico-Heptyl Series.—A. Ladenburg.—The silico-heptyl ether, $Si(C_7H_5)_3OC_2H_5$, is a substance not acted upon by contact with air, not decomposed when treated at 250° with alcoholic ammonia solution, and decomposed by water at a temperature of 200°. Among the products of decomposition is the body $SiC_6H_{13}(OH)$, mixed with other substances having a higher boiling-point, and from which it was impossible to separate this substance. When the silico-heptyl ether is treated at 180° with chloracetyl (equal number of molecules of each of these bodies) in a sealed tube, and the resulting product fractionally distilled, two substances are obtained, one of which, boiling at between 70° and 80°, was proved to be acetic ether; the other, boiling at between 142° and 145°, was, on analysis, found to consist of $SiC_6H_{13}Cl$, silico-heptyl chloride; exact boiling-point when pure, 143·5°; smells like camphor; sp. gr., at 0°, 0·9249; is not decomposed by alcohol alone, but is instantaneously decomposed by aqueous and alcoholic solutions of ammonia, and by aqueous solution of nitrate of silver. By the action of liquid ammonia, the silico-heptyl chloride yields a compound, $SiC_6H_{16}O$, a fluid boiling at 153·5°; vapour density = 124·3; constitutional formula, $Si(C_2H_5)_3(OH)$. The author proposes for this new class of compounds the name of silicols. This substance is a carbohydrate. Triethyl-silicol is insoluble in water, miscible with ether and alcohol, and burns with a bright flame, leaving silica; smells like camphor; sp. gr., at 0° = 0·8709.

New Locality in the Ural (Russia) where Diamonds Occur.—G. Rose.—After first briefly alluding to the finding of a diamond in Bohemia about two years ago, the celebrated *savant* communicates the finding of very small-sized diamonds, not as usual among the detritus of disintegrated rocks, but imbedded in xanthophyllite, a mineral occurring in the talcose schist of Achmatowsk, near Statoust, in the Southern Ural. The researches of Drs. Jeremejew and Lissenko, at St. Petersburg, leave no doubt of the correctness of this important discovery, which is of great interest in reference to the origin and formation of diamonds, which, in the locality alluded to, as also in the Brasil, occur in so-called metamorphic rocks. The author considers that diamonds may be remnants of organic material, the great mass of which has been destroyed by the metamorphosis the

rocks, originally of so-called Neptunic origin, have undergone; but no reply can be given to the question, why in the itacolumite of the Bresil the diamond should have been formed, and in that of Silesia (Streblen) only graphite.

Pyrocatechin Met with as a Constituent of a Living Plant.—Dr. E. von Gorup-Besanez.—While engaged with a chemical research of the leaves of *Ampelopsis hederacea* (so-called wild vine), the author found that the filtrate of a precipitate caused by acetate of lead on being neutralised with milk of lime turned first bright green, then brownish green, becoming at last nearly black, reactions exhibited by pyrocatetchin. On entering more particularly into this matter, the author succeeded in extracting from 2½ kilos. of the fresh green leaves of the plant, a small quantity of a body, which in all its reactions, agreed with those of pyrocatechin, viz., solubility in water, alcohol, and ether; precipitation of aqueous solution by acetate of lead; reduction of solutions of copper and silver when gently heated; olive-green colouration with somewhat oxidised solution of sulphate of iron, and emerald-green colouration with chloride of iron, turning violet by the addition of a drop of a dilute solution of bicarbonate of soda; lastly, microscopical research exhibited perfectly defined crystals of pyrocatechin. Although this body has been discovered by Eisfeldt in Malabar kino, but not in Butea kino, it does not follow that pyrocatechin should be present in the living plant *(Pterocarpus marsupium)* from which the former kind of kino is obtained. Moreover, the preparation of the drug alluded to is by no means well known; according to Hoppe-Seyler's researches, pyrocatechin is formed from carbohydrates when heated along with water under pressure, as well as by treating the carbohydrates with alkalies. In addition to pyrocatechin, the author of this memoir found, in the leaves alluded to, bitartrate of potassa, tartrate of lime, free tartaric acid, gum, and a mixture of dextrose and levulose, the former predominating.

Lecture Experiment—The Sounds (Das Tönen) of Reciprocal Flames.—M. Ballo.—The contents of this paper cannot be well understood without the reproduction of the annexed woodcut.

Anilides of the So-Called Carbohydrates.—H. Schiff.—After first briefly referring to the researches of R. Sachsse (see CHEMICAL NEWS, vol. xxiv., p. 263), and next to his own researches on the action of aniline upon glycose (*Ann. d. Chem. u. Pharm.*, cxl., p. 123; cliv., p. 30), the author further states that when equal parts by weight of anhydrous glucose and aniline are mixed and heated there is obtained, with elimination of water, a deep yellow-coloured mass, which is decomposed by water and dilute acids; in its constituents any excess of aniline can, therefore, only be removed by benzine. The composition of this glucosanilide is $C_{18}H_{17}NO_5 = C_6H_{12}O_6 + C_6H_7N - H_2O$. The action of aniline upon cane sugar is far more difficult, and, since it requires a temperature of from 200° to 220°, the greater part of the sugar is converted into caramel, and an impure compound is obtained. The author, therefore, caused aniline to react upon pure caramel, prepared at a temperature of from 220° to 230°; formula, $C_6H_8O_4$. At 200°, this substance dissolves readily in aniline, the excess of which having been first removed by distillation, the residue is treated with ether, yielding a brown-coloured flocculent substance readily soluble in hot alcohol. After having been purified by being treated with animal charcoal, the composition of this combination was found to be $C_{30}H_{21}N_3O_5 = C_{12}H_{14}O_6 + 3C_6H_7N - 3H_2O$. This body is a fusible substance, glass-like on solidifying; combines with acids, the hydrochlorate forming with platinic chloride an amorphous cinnamon-brown coloured double salt, $2C_{30}H_{21}N_3O_5.H_2PtCl_6$. The combination between aniline and the glucose remnants *(Glycose rückständen)* may be expressed by the following formula:—

$$\left\{\begin{array}{l} CH.N.C_6H_5 \\ CH-\cdot \\ CH-\cdot \\ \end{array}\right\}>O$$
$$\left\{\begin{array}{l} CH-\cdot \\ CH-\cdot \\ CH_2-\cdot \\ \end{array}\right\}>O$$
$$\left\{\begin{array}{l} CH_2-\cdot \\ CH-\cdot \\ CH-\cdot \\ CH.OH \\ CH.OH \\ CH.N.C_6H_5 \end{array}\right\}>N.C_6H_5$$

Starch is converted into dextrine when boiled with aniline, and gum, as well as dextrine, does not yield, it appears, any definite compound with aniline, which, at 200°, does not also act upon glycerine.

Oil Contained in the Pips of Grapes and Raisins.—A. Fitz.—This very lengthy memoir is divided into the following sections:—Description of the physical properties of this oil and of its products of saponification by means of caustic potassa; investigation of the fatty acids and the derivatives thereof; erucasic and brassidic acids; action of fusing caustic potassa upon erucasic acid.

So-Called Glycerin-Ether.—H. von Gegerfelt.—After referring to the researches of Linnemann and Zotta on a compound resulting from the action of chloride of calcium upon glycerine, which the chemists just named state to be identical with Tollens's monallylin = $C_9H_{10}O_2$ or glycerin-ether, the author states that he discovered a substance of the same composition, by the distillation of glycerine left in a retort after the preparation of allyl alcohol. The purified substance boils at between 170° and 172°; is colourless, somewhat thick, and miscible with water, alcohol, and ether in every proportion; sp. gr., at 17° = 1·0907. Tollens's monallylin boils at 240°; sp. gr., at 0° = 1·116. Linnemann's and Zotta's compound boils between 169° and 173°. The author winds up his paper with a discussion on the rational formula to be given to these compounds, but states that, owing to not having a sufficient quantity of material, he could not finish his experiments at present, intending, however, to return to this subject.

Observation on a Paper on Bryonicin.—L. de Koninck and P. Marquart.—The authors mainly state that all they have stated in a formerly published paper on bryonicin (see CHEMICAL NEWS, vol. xxi., p. 227) is to be transferred to nitro-naphthaline and its derivatives. Researches now instituted with the root of the *Bryonis dioica* led to a negative result, and, by what the authors relate, it would appear that the chemist then (viz., at the time of communication of the first experiments) attached to the manufactory of the last-named author either made a mistake, or played them a trick, when he asserted that the material the authors experimented with and published their researches on was obtained from the root alluded to.

Some Mistakes Published in the Memoir "Mesure des Propriétés Explosives du Chlorure d'Azote," by Drs. H. Sainte-Claire Deville and P. Hautefeuille.—J. Thomsen.

Action of Hydrobromic Acid upon Mononitro-Naphthaline.—H. Baumhauer.—After first referring to his former researches on the action of hydrobromic and hydrochloric acids upon mononitro-benzol, the author proceeds to relate the results of his experiments on the action of hydrobromic acid at 195° upon mononitro-naphthaline, the substances being heated in sealed tubes. One of the two new bodies formed by this reaction did not possess basic properties, but was found to be, after having been purified, a crystalline white-coloured substance, fusing at 110°, and exhibiting a distinct reaction of bromine. The other body, a fluid, boiled at between 275° and 295°, and was also free from nitrogen, but contained bromine. The reaction differs in this instance from that which obtains with nitro-benzol. Since, in this instance, the nitro-group is eliminated, and not converted into NH_2, the process may be illustrated by the following formula:—

$$C_{10}H_7.NO_2 + 2HBr = C_{10}H_7Br + Br + H_2O + NO.$$

If, in this manner, 2 molecules of nitro-naphthaline have been decomposed, the 2 atoms of bromine set free are sufficient to convert 1 molecule of monobrom-naphthaline into bibrom-naphthaline—

$$C_{10}H_7Br + 2Br = C_{10}H_6Br_2 + 4Br.$$

Freezing-Point of Bromine.—H. Baumhauer.—Beginning with the observation that great difference of statements exist on this point, and quoting as instances that Dr. Roscoe, in his excellent book on chemistry (German edition, 1871), states that bromine is solidified at −22°, while Dr. von Gorup-Besanez (1871) mentions −7·3° as the freezing-point of bromine, the author has verified this matter with perfectly pure and anhydrous bromine. As result of his experiments, he finds that this haloid freezes at −24·5, forming, not as generally stated, a lead-grey coloured, but a reddish-brown coloured, solid crystalline mass. Since, in the presence of water, bromine forms a hydrate which has a far higher freezing-point, the author thinks that the quotation −7·3° for the freezing-point of bromine has arisen from the fact that a hydrate of that element has been experimented with.

On Phenaconic and Fumaric Acids.—L. Carius.—The contents of this paper are to be considered as a preliminary notice; as yet the author only calls attention to the fact elicited by his researches that phenaconic acid is identical with fumaric acid. The complete results of the researches on this subject will be published later.

Chemistry at the Meeting of the Russian Savants and Philosophers at Kiew.—V. von Richter.—During the meeting of the British Association at the modern Athens, the capital of Scotland, the *savants* and philosophers of the Russian empire assembled in large numbers at Kiew for a similar purpose. From the contents of this lengthy memoir, it appears that chemistry was fully and creditably represented by men who are, in all respects, an honour to their country. As the brief quotations made here are to be published in more complete form at a future day, we do not enter into the details of the contents of this memoir, but we may yet mention that Kiew has been selected on account of being the centre of the highly developed beet-root sugar industry of south-eastern European Russia, as well as on account of its excellent situation and celebrated university.

Zeitschrift für Chemie von Beilstein, No. 13, 1871.

This number contains the following original papers and memoirs:—

Quantitative Estimation of Sulphuretted Hydrogen mixed with Carbonic Acid.—R. Fresenius.—A strong solution of sulphate of copper is first intimately mixed with and absorbed by pea-sized lumps of pumice-stone, and this mass dried at first gently, and afterwards heated to about 150°—160°; the dried lumps are next placed in U-shaped tubes, that placed next to the gas-evolving apparatus being partly filled with fused chloride of calcium; 14 grms. of the pumice-stone, prepared as mentioned, may absorb 0·2 grm. of sulphuretted hydrogen; the material alluded to is very useful for determining sulphuretted hydrogen and carbonic acid, the latter being, of course, absorbed by soda-lime, and the gases dried previous to reaching the absorbents in ball-soda.

Quantitative Estimation of the Tannin contained in Oak Bark.—C. Neubauer.—The author describes at length a very complicated process for the estimation of the substance alluded to, the process being based upon the fact that when a solution (infusion) of oak bark is mixed with indigo-carmine, and permanganate of potassa added, the blue colour of the indigo is destroyed simultaneously with the tannin. The process described requires several titrated liquids, viz., a solution of indigo-carmine, a standard solution of tannin, a standard solution of permanganate, and a decimal normal solution of oxalic acid. Although the process here detailed may yield very correct results in the hands of an experienced analytical and volumetrical chemist, it is not well suited for technical use in tan-yards.

More Important Gravimetrical Methods for the Quantitative Estimation of Arsenic.—R. E. O. Puller.—The author

compares together the process of estimation as arsenicum-trisulphide, as ammonium-magnesium-arseniate, and as uranium oxide-arseniate. As regards the first-named, it may be used for the quantitative estimation of arsenic by removing any free sulphur it contains by the aid of sulphide of carbon; the precipitate (tersulphide of arsenic) may be heated without loss even to 160°. As regards the second, the author quotes its degree of solubility in various fluids: 1 part of the anhydrous salt is soluble in 2784 parts of water; 15,904 parts of a mixture of 1 part of ammonia and 3 parts of water: in 1386 parts of a solution of 1 part NH_4Cl in 60 parts of water; in 886·7 parts of a solution consisting of 1 part of NH_4Cl in 7 parts of water; in 2879 parts of a mixture of 1 part of NH_4Cl in 10 parts of ammonia (sp. gr., 0·96) and 60 parts of water; in 32,827 parts of Fresenius's magnesium mixture. Dried at 100° the composition of the ammonium-magnesium-arseniate is $2(NH_4MgAsO_4)+H_2O$; carefully ignited in a current of oxygen gas the salt leaves $Mg_2As_2O_7$; the third-mentioned compound, produced by acetate of uranium in a solution of arsenic acid, is insoluble in water and acetic acid: boiling of the liquid aids the precipitation greatly, and the settling of the precipitate is greatly promoted by the addition of a few drops of chloroform; the washed and dried precipitate should be ignited in a current of oxygen, or, before ignition, moistened with some nitrate of ammonium solution; the ignited precipitate consists of $(UrO_4)As_2O_7$; results very correct.

Neues Jahrbuch für Pharmacie, von Dr. F. Vorwerk, October, 1871.

This number contains the following original papers and memoirs:—

Progress of the Cultivation of the Cinchona Bark.—Dr. F. A. Flückiger.—A botanico-pharmacognostical essay, exhibiting, in a clearly written style, the real value of this important subject.

Chemical Investigation of the Fruit of the Vaccinium Vitis-Idæa (the Cowberry, or Red Whortleberry).—Dr. Grüger.—The berries alluded to belong to the cranberry family, and grow wild in many parts of Europe. The berries contain in 100 parts:—Water, 85·611; soluble matter, 10·185; insoluble, viz., cellulose, pectose, &c.. 4·204. The juice consists, in 100 parts, of:—(*a*) Organic matter, viz., free acid, hydrate of malic, 1.9750; grape sugar, 5·1850; tannic acid, 0·4760; albuminous matter, pectine compounds, and suspended fatty matter, 2·3330; (*b*) Inorganic matter, viz., potassa, 0·0580; lime, 0·1280; magnesia, 0·0114; peroxide of iron, 0·0186; water, 89·8150; total, 100·000. This paper contains, further, a very complete and detailed account of the method of analysis pursued by the author in this research.

Methods for the Preparation of Tartar Emetic free from Arsenic.—S. Lovén.—This paper describes a series of pharmaceutical experiments made with the view to ascertain under what conditions the salt alluded to may be obtained free from arsenic, the antimonial preparation which forms the starting-point of the preparation being the black commercial sulphuret of antimony. The author found that when this compound is treated with hydrochloric acid (sp. gr., 1·17), and the mixture at first slowly heated and brought to the boiling-point, and kept boiling as long as sulphuretted hydrogen is evolved, and afterwards slowly cooled, the sulphuretted hydrogen present in the liquid causes the complete precipitation of the arsenic originally present in the crude sulphuret of antimony.

NOTES AND QUERIES.

Dehydrating Oxalic Acid.—I should feel obliged if any of your correspondents would inform me of the best mode of dehydrating oxalic acid; and also if a mixture of hehydrated oxalic acid and ether would form oxalic ether.—Q. R.

Gas-Proof Fabric.—(Reply to "L.R.C.P. Ed.").—You will find mentioned in Cooley's "Cyclopædia of Practical Receipts," under the head of "Varnish," several mixtures which will answer your purpose; well-boiled linseed oil, or a solution of caoutchouc in that fluid, are generally applied.

The Solubility of Black Silk.—I enclose two patterns of black silk, and according to one of your contributors silk is soluble in hydrochloric acid. I failed in half an hour to dissolve the black portion of both samples. The orange spot of one and green stripe of the other dissolved immediately. The black colour impedes my microscopical observations. Will the black dye impede or prevent the action of the hydrochloric acid? The determination of the composition of woven and dyed fabrics is certainly a work of great difficulty, and in the present dishonest state of trade instant detection is a desideratum. All I know about the patterns is that the dresses are said to have worn badly. Strong caustic soda breaks up the fibres transversely, and discharges much of the colour. I fail to obtain the usual appearances of silk under such treatment.—W. T. S.

TO CORRESPONDENTS.

ERRATUM.—Vol. xxiv., p. 283, line 34 from top, *for* "(FeO_3)" *read* "(Fe_2O_3)."

A. H. A.—(1.) The CHEMICAL NEWS will contain reports. (2.) Messrs. Hopkin and Williams, New Cavendish Street, W.C.

B. W. Gibsone, M.A.—Thanks for your letter, but the subject has been discussed so fully in the *Times* that it will not interest our readers.

L. P.—You had better apply to an analytical chemist.

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THE

MANUFACTURE OF CHLORINE.

ALTHOUGH the development of the process for the Manufacture of Chlorine by means of oxides of manganese regenerated by means of magnesia, to which reference was made on this page some months ago, has been sorely delayed by serious ill-health on my part, I am nevertheless in a position to announce that that process, in a certain modified form which it has now assumed, has proved capable of yielding even more advantageous results than I formerly claimed for it. It will necessarily be yet some time before I can be able or free to supply working details. Meanwhile, I beg to report as follows :—

I. That the new form of process yields, in the free state, practically *all* the chlorine contained in the salt decomposed, being at about the rate of *a ton of bleaching-powder per fourteen hundredweights of salt.*

II. That, of the chlorine which it thus yields, a sufficient proportion to give a ton of bleaching-powder for about each thirty hundredweights of salt is ENTIRELY UNDILUTED, and therefore available for the manufacture of bleaching-powder in the chambers at present in use. This portion of the chlorine is generated in the ordinary (Weldon) stills, and is in precisely the same condition as that produced in my process as at present practised, or as that generated by means of native manganese.

III. That, while the remainder of the chlorine is *dilute*, it is not more so than that produced in any process yielding dilute chlorine only, and is free from carbonic acid, the sole diluent being nitrogen.

IV. That the process, in its new shape, is performed without blowing engines, and *without machinery of any kind*, by appliances already in use in every alkali-work, the only thing employed in it which has any "moving parts" being an ordinary liquor-pump.

The new form of process thus yields more *strong* chlorine, per given quantity of salt, than has ever hitherto been produced by any process whatever, and, in addition, yields the remainder of the chlorine in as good a state as the richest chlorine producible by any process which yields dilute chlorine only. While permitting the present production of bleaching-powder, per given quantity of salt, to be nearly *quadrupled*, it enables one-half of the quadrupled production to be made from undiluted chlorine, in such chambers as have been employed hitherto, and one-half of the chlorine to be generated in the present stills. Putting the whole cost of the process on the *strong* chlorine only, the cost of the latter, per ton of bleaching-powder, promises to be lower than it has ever been yet, the other half of the chlorine counting as not costing at all. Lastly, the special plant required for the new form of process is so simple and inexpensive, that the cost of a plant for any considerable production will probably not exceed £20 for each ton of bleaching-powder to be made by it per week.

WALTER WELDON.

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December 12th, 1871.

THE CHEMICAL NEWS.

VOL. XXIV. No. 631.

NOTE ON FUCUSOL.*

By JOHN STENHOUSE, LL.D., F.R.S.

IN a paper which I communicated to the Royal Society of London in 1850,† "On the Oils produced by the Action of Sulphuric Acid upon various Classes of Vegetables," after describing the sources, method of preparation, and characteristic properties of furfurol, and its educts, I described another isomeric substance closely resembling furfurol, both in its physical and chemical properties, and which I named fucusol from the source whence it had been obtained, namely, *Fucus nodosus*, *F. vesiculosus*, and *F. serratus*, &c.

The nature of the substance which yielded furfurol was involved in considerable obscurity until the publication of Gutzkow's paper "On the Furfurol-yielding Substance in Bran,"‡ which he found to be present in it to the amount of 15 to 20 per cent, and which, when boiled with dilute sulphuric acid, was converted into a brownish sweet syrup. This is the substance from which furfurol is obtained by distillation with sulphuric acid or hydrochloric acid.

Fucusol.

I have found that when sea-weeds were boiled with very dilute sulphuric acid, containing about 3 per cent of acid, that a substance corresponding to that described by Gutzkow was obtained, which, when distilled with sulphuric or hydrochloric acid, yielded fucusol. In my paper of the year 1850 I have described the difference in the physical properties of furfurol and fucusol, and also the difference between the products obtained by the action of ammonia upon them and the bases derived from these. I have again repeated the examination of these substances with great care, and find my former statements to be correct. In addition to these, I have recently prepared the aniline compound analogous to furfuraniline.‖ *Fucusaniline* hydrochlorate crystallises in needles of a magnificent purple colour, and closely resembles the corresponding furfurol compound.

As is well known,§ when furfurol is boiled with water and silver oxide, metallic silver is deposited and silver pyromucate formed, which remains in solution. In a similar manner I found that when fucusol was digested at 100° C. for five or six hours with an excess of recently precipitated silver oxide and a considerable quantity of water, its odour gradually disappeared, and at the completion of the reaction a silver-salt was found in solution, whilst metallic silver was deposited, partly in a granular state, and partly as a mirror, on the bottom of the flask. Sufficient hydrochloric acid was then added to the hot filtered solution to precipitate the silver. After the removal of the argentic chloride it was carefully evaporated at a temperature below 100°; and the brown semi-crystalline mass thus obtained boiled with light petroleum oil, which dissolved the acid and left the colouring matter. One or two crystallisations from boiling water rendered it quite pure.

Analysis.—0·188 grm. substance gave 0·370 grm. carbonic anhydride and 0·080 grm. water.

		Theory.	Found.
C_5	60	53·56	53·68
H_4	4	3·57	4·25
O_3	48	42·87	—
	112	100·00	

From this analysis, it will be seen that this acid, which I propose to call *β pyromucic acid*, is isomeric with ordinary pyromucic acid, from which, however, it slightly differs in its physical properties. The melting-point of pure β pyromucic acid is 130°, being nearly the same as that of the acid obtained from furfurol, which I found to be 133°, and which Schwanert* gives as 134·3°. The β pyromucic acid from fucusol crystallises from its aqueous solution in small rhomboidal plates, whilst the acid which I had prepared from furfurol crystallised in flat needles.

Silver β pyromucate.—This compound was prepared from the pure β acid by boiling it for a short time with silver oxide and a sufficient quantity of water, filtering, and setting aside to crystallise. A single re-crystallisation from boiling water, in which it is only moderately soluble, rendered it quite pure. On cooling the hot aqueous solution, the silver β pyromucate is obtained in long flat needles, whilst the corresponding salt of the ordinary acid forms small crystalline scales; 0·505 grm. of silver-salt gave 0·330 grm. argentic chloride, which corresponds to 49·18 per cent of metallic silver. The formula $C_5H_3AgO_3$ requires 49·32 per cent.

From this silver determination it will be seen that this compound is isomeric with the ordinary silver *α* pyromucate, $C_5H_3AgO_3$.

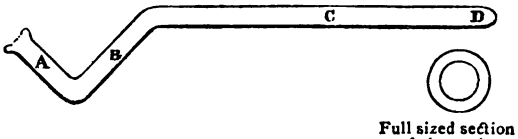
* A Paper read before the Royal Society.
† *Phil. Trans.*, 1850, p. 467.
‡ *Zeits. Chem.*, 1870, p. 360.
‖ *Proc. Roy. Soc.*, vol. xviii., p. 537.
§ *Ann. Chem. Pharm.*, vol. cxvi., p. 259.

ON THE SOLVENT POWER OF LIQUID CYANOGEN.†

By G. GORE, F.R.S.

IN the following experiments a number of stout tubes of refractory glass of the annexed shape were employed

Scale ¼.



Full sized section of glass tube.

Each tube was closed at one end, and had a flanged mouth at the other. The limb A was 1½ inches long, the limb B 2 inches, and C 7 inches.

In making the experiments, each tube was first filled to an extent of 5½ inches of its length, with highly dried crystals of mercuric cyanide: a small fragment of asbestos‡ was then pushed tightly against the end of the cyanide by means of a thin rod of gutta-percha, and the bend of the tube cleaned by means of a slender brush. A number of taper plugs of gutta-percha were previously made, by softening the end of a rod of that substance in boiling water, and then chilling it; and loops of thin copper wire were also prepared for the purpose of securing the plugs.

Having placed in the bend of the tube the substance to be operated on, a plug was wetted with chloroform, and at once firmly inserted in the mouth of the tube and secured by means of the wire. A wet rag was wrapped round the limb B, and the portion of the limb C containing the cyanide was inserted in a loosely-fitting tube of copper-foil within a tube of wrought-iron about 2 feet long, supported in a nearly horizontal position with the end D the lowest.

A vessel having been previously arranged to drop cold water continually upon the wet rag, a glass screen was placed by the side of the exposed part of the glass tube, and heat was gradually applied, by means of a row of Bunsen's burners, to the part of the iron tube containing the limb C. In about four minutes liquid cyanogen began

* *Ann. Chem. Pharm.*, vol. cxvi., p. 257.
† Read before the Royal Society.
‡ This may be dispensed with if the mercuric cyanide is perfectly dry.

to form, and in about five minutes longer about 2 inches in length of the bend was filled with that liquid, and the heat was then discontinued. The temperature of the iron tube was below that of visible redness: if the heat applied was not too great the glass tube retained its original form, and might afterwards be easily removed from its casing and set aside for future examination. A white fog, and signs of a heavy vapour in the bend of the tube, always immediately preceded the formation of the liquid. In many instances some of the cyanogen retained the liquid state for several days, and even weeks, especially if the bend of the tube was kept cool by means of a wet sponge.

The cyanide employed in the experiments should be crushed to a coarse powder, and highly heated a long time, with constant stirring, until it is of a slightly brown colour, otherwise, immediately previous to the appearance of the liquid cyanogen, a small quantity of a brownish treacly liquid distils over and affects the results.

More than 130 substances, including solids and liquids, and a great variety of simple and compound bodies, were subjected to the action of the liquid; the substances were in nearly all cases as free from moisture as it was possible to obtain them. The following are the results obtained:—

Substances Soluble in Liquid Cyanogen at 60° F.—Camphor dissolved rapidly and copiously. Hydrate of chloral quickly and freely. Solid C_2Cl_6 was freely soluble. Iodine was moderately soluble, and formed a deep red liquid. Picric acid moderately soluble; the solution was yellow. White phosphorus dissolved very slowly, and to but a small extent.* Gum benzoin, also white cane sugar, dissolved slowly and sparingly. Gum assafœtida and gamboge dissolved slightly, and formed yellowish liquids. Bisulphide of carbon, C_2Cl_2 and C_2Cl_4 mixed perfectly with the liquid; CCl_4 mixed less perfectly. Water was only slightly absorbed.

Substances Insoluble in Liquid Cyanogen at 60° F.—Water (nearly insoluble) would not mix with the liquid,† and produced no chemical change. Iodic acid. Fine lamp-black. Well-burned wood-charcoal (two kinds). Crystals of boron. Boracic acid. Crystals of silicon. Precipitated silica. Titanic acid. A fragment of sulphur. Selenium. Selenious acid. Tellurium. Arsenic. Arsenious and arsenic acids. Realgar. Orpiment. Antimony. Antimonic oxide. Antimonic acid. Fused fluoride of antimony. Red sesquisulphide of antimony. Bismuth. Fluoride of bismuth. The oxides of iridium and silver. Argentic nitrate, fluoride, chloride, iodide, and iodate. Mercury. Mercuric chloride. Copper. Cuprous iodide. Chloride of nickel. Iron. Mundic. Peroxide of manganese. Fluoride of manganese. Chromic oxide. Violet chloride of chromium. Oxide and fluoride of uranium. Red oxide and peroxide of lead. Plumbic chromate. Tin. Cadmium. Sulphide of cadmium. Zinc. Tungstic and niobic acids. Oxide of cerium. Carbonate of glucinum. Aluminium. Magnesium. Magnesia. Dry lime. Anhydrous carbonate of sodium. Potassic nitrate, bromide, iodate, and fluo zirconate. Bichromate and bitartrate of rubidium. Bitartrate of cæsium. Chloride and carbonate of ammonium. Oxalate of cerium. Paracyanogen. Cyanide of mercury. Nitrocyanide of titanium. Pyrogallic, gallic, tannic, and succinic acids. Sulphate of quinine. Alloxan. Starch. Milk-sugar. Egg-albumen. Gun-cotton. The gums ammoniac, animi, copal, dammar, elemi, galbanum, guaiacum, juniper, kowrie, mastic, myrrha, olibanum, opoponax, sagapenum, seed-lac, shellac, thus, and tragacanth. Yellow resin. Egyptian asphalte. Gutta-percha. India-rubber. Paraffine. Anthracene. Stearine. Bees'-wax. Spermaceti. Aloes—Barbadoes, Cape, hepatic, and socotrine. Brazil-wood. Red santal-wood. Cuba yellow fustic. Terra japonica.

The following substances produced some changes, but did not dissolve:—Perfectly white and dry iodic acid made the liquid of a pink colour. Dry selenious acid and iodate of potassium became slightly pink. Yellow chloride of nickel (nearly anhydrous) became at once green.* Cuprous iodide acquired the colour of vermillion. Sesquicarbonate of ammonium became brown. The gums myrrha and guaiacum coloured the liquid yellowish. Bisulphide of carbon, saturated with sulphur, rapidly set free its sulphur in the form of crystals, the bisulphide being absorbed and dissolved by the cyanogen. A saturated solution of phosphorus in bisulphide of carbon quickly liberated its phosphorus in a similar manner, but not in a crystalline form. The contact of moisture and an alkaline substance with the liquefied gas caused the formation of a brown solid body, apparently paracyanogen.

From these results it is evident that liquid cyanogen, at 60° F., is a remarkably inert body, and possesses very little solvent power for substances in general; out of 132 substances only 14 were dissolved, and not a single one exhibited signs of strong chemical action.

* See also "Gmelin's Handbook," vol. viii., p. 147, article "Cyanide of Phosphorus."

† See "Gmelin's Handbook of Chemistry," vol. vi., p. 388.

ON THE ANALYSIS OF CHROME ORE.†

By JOHN CLARK, Ph.D.

In 1862 Dr. Genth called attention to the discrepancies between his own and other chemists' analyses of chrome ore, and even at the present day there are few analyses in which, generally speaking, the results of chemists disagree to a more marked extent. In addition to the difficulty of obtaining concordant results by different chemists, the consumers of chrome ore complain that in the manufacture of bichromate of potash there is a loss of oxide of chromium which they can only account for on the supposition that the chemist generally reports too high a result.

These complaints do not appear to be altogether unfounded. Undoubtedly, many discrepancies are due to differences in the sample, but still more so to the inexperience of the analysts and the difficulty of obtaining correct results by the ordinary methods of analysis. The impossibility of obtaining by washing alone an oxide of chromium precipitate perfectly free from alkali, after fusing the ore with bisulphate of potash, was recognised by Dr. Genth, who recommended that, before weighing, the ignited precipitate should be boiled with water containing sulphurous acid, to reduce the chromate which had been formed, and that the oxide produced by the reduction should be precipitated with ammonia. By this means the weight of the precipitate of oxide of chromium is considerably reduced, but in the experiments I have made never quite pure. Instead of boiling the ignited precipitate with water containing sulphurous acid, the precipitate may be boiled with dilute acetic acid, and the chromic acid thus removed estimated with a dilute solution of double sulphate of iron and ammonia of known strength. The oxide of chromium in the form of chromate usually amounts even in the most carefully washed precipitate to 0·76 per cent. Perfectly accurate results by the precipitation method without subsequent correction can, I believe, only be obtained in the absence of sulphates, as, for example, by the process recommended by M. Clouet, manufacturer of bichrome in Havre (see *Annales de Chemie et Phys.*, 4 series, t. xvi., p. 90). M. Clouet's process consists in fusing the finely pulverised chrome ore with from five to six times its weight of pure carbonate of soda in a platinum crucible for five or six hours at a bright red heat without the addition of any oxidising agent, reducing the purified chromic acid formed with alcohol in presence of hydrochloric acid, and precipitating

* Probably in consequence of the presence of a trace of moisture.

† Read before the Chemical Section of the Glasgow Philosophical Society. The author not thinking the official report of his paper sufficiently clear, has requested us to publish it in full.—Ed. *C.N.*

the oxide of chromium with ammonia. In this case, owing to the comparatively small amount of salts present and the absence of sulphates, a perfectly pure oxide of chromium precipitate may be obtained. Although M. Clouet's method yields the correct amount of oxide of chromium, it is not well adapted for the laboratory on account of the length of time required for the complete oxidation of the oxide of chromium in the ore.

Perfectly accurate results may be obtained by the following volumetric method, which is at once simple and expeditious.

25 grs. of the finely powdered ore are intimately mixed with 200 grs. of hydrate of sodium and calcined magnesia in the proportion of five parts of hydrate of sodium to three of magnesia, and the mixture exposed in a platinum crucible to the heat of an ordinary Bunsen burner for three-quarters of an hour with the lid off, and afterwards for a quarter of an hour with the lid on. Under the influence of the hydrate of sodium and magnesia oxidation takes place at once, and is practically complete in less than an hour. The crucible with its contents is then placed in a basin containing water; the contents are washed out as far as possible with water, and afterwards with dilute sulphuric acid, which must be free from nitric acid. An additional quantity of pure dilute sulphuric acid is then added to the contents of the basin, and heat applied, when everything should dissolve (except, perhaps, a few flakes of silica). To the clear yellow solution is added a weighed quantity of double sulphate of iron and ammonia of known strength and more than sufficient for the reduction of the chromic acid. The excess of unoxidised iron is then estimated with a weak standard solution of bichromate of potash, and the amount of oxide of chromium in the ore calculated from the quantity of iron oxidised. It not unfrequently happens that a little of the chrome ore escapes decomposition, this must be filtered off after the chromic acid in solution has been estimated, and re-fused with hydrate of sodium and magnesia as before, as it is generally richer in oxide of chromium than the original ore. It may readily be supposed that soda-lime or a mixture of hydrate of sodium and lime would induce oxidation quite as readily as a mixture of hydrate of sodium and magnesia, but this is not the case. When chrome ore is heated over an ordinary Bunsen burner with soda-lime —hydrate of sodium and lime—or even with a mixture of hydrate of sodium and magnesia which has been ignited before admixture with the ore, only a trifling oxidation takes place.

The results obtained by the process which I have described seldom vary 0·2 per cent. I have had occasion to submit this process to several chemists; among others to the director of the School of Mines in St. Petersburg, who has not only expressed a very favourable opinion of its accuracy, but, as I understand, adopted it in the testing of the Russian ores.

The other ingredients usually existing in chrome ore (viz., oxide of iron, alumina, magnesia, and silica) may be estimated by the process described by Fresenius. I consider, however, that M. Clouet's method of estimating the iron, as described in the paper to which I have referred must give incorrect results, and I direct attention to this more especially on account of the formulæ which that gentleman has given to express the various proportions in which the oxide of iron and oxide of chromium exist. After fusing the ore with carbonate of sodium, M. Clouet assumes that all the alumina is soluble in water (as aluminate of sodium), and that the residue, when the ore is decomposed, consists only of oxide of iron, magnesia, and silica, so that when the residue is dissolved in hydrochloric acid, evaporated to dryness to render the silica insoluble, and filtered, the precipitate produced by the addition of ammonia to the filtered liquid will be pure oxide of iron, which may be collected, washed, dried, ignited, and weighed. This, so far as I understand from his paper, is the method which M. Clouet employed in estimating the iron, although he mentions that the iron might also be estimated by a standard solution of permanganate of potash. By this method of analysis M. Clouet finds that all the varieties of chrome ore he has analysed have a definite chemical composition, and contain the oxide of chromium and oxide of iron in definite proportions after deducting the silica, alumina, and magnesia, which he regards as the matrix of the true ore.

In a number of analyses which I have made by M. Clouet's method I was never able to render the alumina completely soluble in water by fusion with carbonate of sodium, but always found a considerable portion of the alumina in the precipitate which M. Clouet regards as pure oxide of iron, and in numerous analyses of chrome ore which I have made very few of them would be represented by any of M. Clouet's formulæ. Unfortunately, I am not aware of the localities from which my samples were derived, but I do not think it will be out of place to mention the average results which I obtained.

In seventeen analyses of ores containing from 30 to 40 per cent of oxide of chromium, the average amount of protoxide of iron was 15·4 per cent.

In twenty-three analyses of ores containing from 40 to 50 per cent of oxide of chromium, the average amount of protoxide of iron was 14·3 per cent.

In thirteen analyses of ores containing from 50 to 60 per cent of oxide of chromium, the average amount of protoxide of iron was 15·0 per cent (the lowest amount of oxide of iron being 10·6, and the highest 23·14 per cent).

In each case the iron was estimated in the ammonia precipitate by a standard solution of bichromate of potash after reduction with stannous chloride.

I am not prepared to say that the protoxide of iron and oxide of chromium do not exist in definite portion, but if so, then other formulæ in addition to those given by M. Clouet will be required to express their composition.

NOTE ON THE

ESTIMATION OF OXIDE OF CHROMIUM IN CHROME-IRON ORE,

AND ON THE

ANALYSIS OF THIS MINERAL.

By HUGO TAMM.

As I have had much practice and experience in the analysis of chromium ores from all parts of the world, this induces me to discuss Dr. Clark's paper on the same subject, read before the meeting of the Glasgow Philosophical Society of the 4th of December, 1871, and published in the CHEMICAL NEWS, vol. xxiv., p. 286.

1. Dr. Genth's observation must have been corroborated by every chemist. It is *impossible* to obtain oxide of chromium free from alkaline salts by mere washing, after fusing chrome ore with bisulphate of potash, nitre, or a mixture of nitre and carbonate of potash; and in general the presence of alkaline salts is the chief cause of error in the estimation of the percentage of oxide of chromium, which, on that account, is usually reported as too high.

2. A second and not less important cause of error is due to the invariable presence of silica, alumina, and a little oxide of manganese, in the precipitated oxide of chromium, contributing also to the too high result.

3. Dr. Genth's and Dr. Clark's suggestions, relative to the use of sulphurous and acetic acid, are practically of no value.

4. Clouet's process has all the disadvantages inherent to the general process, plus the length of time required by his way of oxidising.

5. If, as Dr. Clark says, one part of chrome ore is thoroughly oxidised in less than an hour by 8 parts of soda and magnesia, this process will prove valuable for the

mere assaying of chrome ores, but it is most objectionable in the case of an analysis, for magnesia is one of the constituents of chrome-iron ores, and, besides, it is difficult to separate from most substances. On the other hand, it is difficult to find caustic soda free from silica and alumina.

The following process, which I have used with advantage, overcomes the difficulties inherent to the analysis of chromium ores:—

(*a*.) Bisulphate of potash is the substance by which chrome-iron ore is most readily attacked; consequently the ore is fused with 15 parts of pure bisulphate of potash, and when the action is over the mass is brought to a bright red-heat, to drive off the excess of sulphuric acid.

The sulphate of chromium thus obtained being insoluble in water and in acids, a mixture of 10 parts of nitre and 10 parts of pure carbonate of potash is thrown in the crucible, and the whole mass is fused and stirred.

In this operation the whole of the oxide of chromium is readily converted into chromate of potash.

The crucible and its contents are thrown into water, and when the disintegration and solution are complete the solution is separated by filtration from the insoluble precipitate, which is then submitted to analysis, and is found to contain, in general, oxide of iron, silica, alumina, magnesia, lime, and a little oxide of manganese.

(*b*.) The alkaline liquor contains chromic acid, silica, alumina, and a little oxide of manganese.

A piece of litmus paper is introduced in the solution, which is well stirred with the left hand, while with the right hand hydrochloric acid or nitric acid, previously placed in a beaker, is rapidly poured in the alkaline liquor until the litmus paper turns red. This being done, and without a moment's interruption, ammonia, previously placed in a beaker, is thrown in the liquor in sufficient quantity to turn the litmus paper blue, and some carbonate of ammonia is then added. By this means silica, alumina, oxide of manganese, and generally a very small proportion of oxide of chromium, are precipitated.

The success of this most important operation depends on the rapidity with which the alkaline liquor is first acidulated and then neutralised. It is absolutely necessary to perform this operation as rapidly as possible, because, on addition of an excess of acid, nitrous acid is evolved, and if ammonia was not used instantly to saturate the acids, a considerable proportion of chromic acid would be reduced.

(*c*.) The liquor is filtered, and thus separated from the source of error,—silica, alumina, &c.,—and the chromium existing in this liquor has only now to be separated from alkaline salts to be obtained perfectly pure.

To effect this object the liquor is acidulated with a large excess of hydrochloric acid. Nitrous acid is evolved, and chromic acid is rapidly reduced to the state of oxide. When the reduction is complete water is added, and then an excess of ammonia, and the whole is boiled. A large excess of chloride of ammonium has been formed, and it is this salt which assists mostly in the separation of oxide of chromium from alkaline salts. The oxide is washed three or four times by decantation. This oxide is not quite free from alkaline salts, sulphates especially. It is absolutely necessary to dissolve it a second time in a large excess of hydrochloric acid, and to re-precipitate it a second time by ammonia, and to wash it until the washings are free from sulphates or fixed salts.

This second operation, which is indispensable, is most efficient, and the oxide then obtained is practically free from alkaline salts.

If we consider (1) that by this process the correct amount of oxide of chromium can easily be estimated in the course of 6 or 7 hours, (2) that the oxide of chromium obtained is quite pure, (3) that all the other substances accompanying chrome oxide may easily be determined and estimated, we must arrive at the conclusion that this process is one of the best that can be proposed.

ON THE

SOLUBILITY OF SOME FORMS OF PHOSPHATE OF LIME.*

By CHARLES P. WILLIAMS,
Director of the Missouri School of Mines.

AGRICULTURAL experience has long appreciated the difference in the rapidity of action of ground bones on the one hand and of some of the phosphatic guanos on the other. The decided preference given to the first form of phosphate of lime and to the various manipulated guanos and so-called superphosphates is not merely the result of prejudice, but is in exact accordance with the results obtained by chemical experimentalists, who have shown that the solubility of tricalcic phosphate in water containing carbonic acid is as various as the source from which it is obtained. Bischoff has shown† that while one part of apatite will dissolve in 393,000 parts of water saturated with carbonic acid, the artificially prepared basic phosphate requires only 1102 parts of the same for its solution. As theoretical considerations would appear to indicate that all forms of phosphate of lime must pass to a condition corresponding to that of the artificially precipitated phosphate before assimilation by vegetation, the rapidity of the action of carbonic acid water in rendering phosphates soluble becomes an indication, measurably, of the relative rapidity of their action when applied as fertilisers, and hence of their comparative values in such capacity. Analytical investigations in this direction would seem to be of more immediate practical value than the simple quantitative determination of the constituents of a phosphatic guano or fertiliser, and may yet serve to harmonise some of the apparent discrepancies now obtaining between the results of the laboratory and the farm. Condition of molecular aggregation, determined by solubility in carbonic acid water, is of at least equal importance as percentage richness in phosphate of lime, and a rapid and reliable analytical method that may discriminate between such conditions of aggregation in superphosphates is a desideratum alike to chemists, manufacturers, and farmers. Justice to all parties concerned makes it imperative that the analyst of an artificial phosphatic guano should distinguish between the original insoluble phosphate of lime and that which has become such by reactions in the article in question; and until this is done the analytical estimations of soluble and insoluble phosphoric acid fall short of furnishing fully reliable data for estimating commercial value. And this is equally true of natural or unmanipulated guanos.

The writer has endeavoured to determine the solubility of some of the best known forms of natural tricalcic phosphate by operating in the following manner:—

A weighed amount of the finely pulverised material was placed in a measured quantity of water (1000 cubic centimetres), and carbonic acid gas passed through the same for fifty hours at a temperature of 60° to 70° F. At the end of this time the liquid was filtered off, nitric acid added to strong acid reaction, the solution concentrated by evaporation, and the phosphoric acid separated by means of molybdate of ammonia. The precipitate thus obtained was treated in the usual manner to convert the phosphoric acid into ammonio-magnesic phosphate, care being taken to allow the solutions in which this was forming to stand at least twelve hours before filtration. To avoid loss, the ammonia water used for washing was in all cases made of uniform strength; the amount used in each analysis was measured, in connection with its proper filtrate, and for each 54 cubic centimetres of the liquor 0·001 grm. was added to the weight of the pyrophosphate of magnesia obtained. This correction for the solubility of ammonia-magnesic phosphate in ammoniated

* Communicated by Dr. Wahl. From advance-sheets of the *Journal of the Franklin Institute.*

† "Elements of Chemical and Physical Geology," Cavendish Edition, vol. iii., p. 27.

water was made in all cases. To render the conditions of the experiments as nearly as possible uniform, the amount of phosphate of lime present was made identical in each case, an analysis of the sample being previously made and a proportionate increase or decrease of amount being taken to correspond to increased or decreased percentage of phosphate of phosphate of lime.

Experiment 1.—Apatite from near Perth, Canada, containing 89·27 per cent $3CaOPO_5$. Amount taken, 0·5 grm. Solution gave 0·0021 grm. PO_5, equivalent to 0·0045 $3CaOPO_5$. This amount corresponds to one part of the phosphate of lime of apatite dissolved in 222,222 parts of water saturated with carbonic acid.

Expt. 2.—Same as in No. 1, but the material levigated. Solution gave 0·0032 grm. phosphoric acid, equivalent to 0·0071 grm. $3CaOPO_5$ or one part in 140,840 parts of water saturated with carbonic acid.

Expt. 3.—Fine ground and pure bone containing 56·78 per cent of phosphate of lime. Amount taken, 0·733 grm. Solution gave 0·0804 grm. phosphoric acid, equivalent to 0·1753 grm. phosphate of lime. One part of the phosphate of lime in raw bones dissolves in 5698 parts of water saturated with carbonic acid. According to Bischoff* fresh ox-bone shavings require 4610 parts, while Liebig† says only 1500 parts of carbonic acid are required.

Expt. 4.—To determine whether the organic matter of the bone had any influence on its solubility, a portion of the material used in Expt. 3 was calcined and the organic matters burned off. The ash corresponded to 61·13 per cent of the original bone, and therefore contained 92·88 per cent of tricalcic phosphate. Amount of bone-ash taken, 0·4805 grm. Solution gave 0·0569 grm. phosphoric acid, equivalent to 0·1246 grm. phosphate of lime, or one part in 8029 ports of water saturated with carbonic acid.

Expt. 5.—A sample of adulterated bone dust of commerce, containing 24·32 per cent organic and volatile matters, 35·06 per cent phosphate of lime, and 26·13 per cent of sulphate of soda (salt cake with a small amount of acid sulphate). Amount taken, 1·3157 grms. Solution gave 0·1111 grm. PO_5, equivalent to 0·2426 grm. $3CaO\,PO_5$—or one part in 4122 parts carbonic acid water. The greater solubility of this sample is, in all probability, due to the formation of some acid phosphate of lime

$(CaO2HOPO_5)$

by the small amount of free sulphuric acid present in the salt cake with which it was adulterated.

Expt. 6.—South Carolina phosphate, from the property of the Charleston Mining and Manufacturing Company, containing 57·89 per cent phosphate of lime. Amount taken, 0·771 grm. Gave PO_5, 0·0647 grm., equivalent to 0·1413 grm. $3CaOPO_5$, or one part in 6983.

Expt. 7.—Same as Expt. 6, but levigated; gave 0·1528 grm. $3CaOPO_5$, or one part in 6544.

Expt. 8.—Phosphatic guano from Orchilla Island. Containing—Moisture, 12·88 per cent; organic and volatile matters, 14·60 per cent; $3CaOPO_5$, 49·67 per cent; $CaOCO_2$, $CaOSO_3$, sand, clay, &c., 22·76 per cent. Amount taken, 0·8970; gave 0·0588 PO_5, equivalent to 0·1248 grm. $3CaOPO_5$, or one part in 8009 parts of water saturated with carbonic acid.

Such well-known guanos as the Navassa and Swan Island were not experimented with on account of their larger percentages of phosphates of iron and alumina.

It is not claimed that these results will indicate the absolute degree of solubility of the several materials in the soil when the water is not saturated with carbonic acid and where there are so many modifying and controlling conditions, but they serve to indicate, with some degree of exactness, the relative rapidity of action of the different forms of phosphate of lime, and to show the wide range of solubility of the compound under similar conditions, according to the source from which it is obtained. They, perhaps, rather enhance than decrease the difficulties in the way of discriminating between the chemically precipitated and the original undecomposed phosphates of a "superphosphate" by throwing suspicion on the absolute exactness of all those methods of separation based upon solubility in weak or organic acids, unless, indeed, the operator is acquainted with the raw materials employed by the manufacturer of such "superphosphate." They and all similar experiments, however, fix the great value of this precipitated or "returned" phosphate, by showing how much more rapid it is in its action than is any form of phosphate, to whatever degree of fineness it may be brought by purely mechanical means of subdivision.

* *Loc. cit.*

† Quoted by Bischoff, *loc. cit.*

SEWAGE AS A FERTILISER OF LAND, AND LAND AS A PURIFIER OF SEWAGE.*

By J. BAILEY DENTON, C.E., F.G.S.,
Hon. Member of the Royal Agricultural Societies of Norway, Sweden, and Hanover.

HAVING recently appeared as a correspondent of the *Times* on the sewage question, it may very reasonably be assumed that I have exhausted the subject, as far as I am personally able to do so; but the fact is, that having in the letters to which I refer explained the advances made by the chemist and the engineer, and shown that there has prevailed, up to this time, a disregard of the properties of different soils for the retention of the fertilising ingredients of sewage, and the purification of the water with which the sewage is mixed, I left the subject where I considered the agriculturist should take it up. Hence my appearance before our Society, at a season when many of its members connected with agriculture will be in London.

I will promise to condense the remarks I have to make as much as possible, in order that there may be sufficient time for the expression of opinions which I shall do my best to challenge.

Though large figures have been put forth, by sundry writers and speakers, of the immense loss this country suffers by casting the sewage of its towns into the rivers, and everybody acknowledges, not only that such waste ought not to continue, but that our rivers should be restored to their original purity, we have not yet brought to practical test the value of sewage to the farmer and the market gardener. Chemists have done their best to rouse public attention to the loss we suffer, and it now remains with the country to adopt those measures which will best conduce to its recovery.

Large as the intrinsic value of the fertilising matter has been shown to be by the chemist, the value of the water in which it is contained has been excluded from his consideration, though farmers and gardeners alike are prepared, after the experience of the recent years of drought, to put a high value on water for its own sake, irrespective of the fertilising elements it contains after sewage has been mixed with it; for they know how serviceable is timely moisture to the germination of seed, and for reviving and sustaining plant growth, independently of its special power of conducting to the roots of plants, in the most acceptable way, those fertilising ingredients which the chemist has valued so highly.

Hitherto, the benefit to be gained by a command of water has been more than counterbalanced by the disadvantages of excess, and the obligation of disposing of the liquid sewage at all times and under all conditions. In referring to water, therefore, I do so only to remark that, large as the theoretical value of the manurial properties of sewage has been declared to be, it may yet bear an increase when the practical mind of the agriculturist is brought to bear on its utilisation, and the dis-

* Read before the Society of Arts, December 6, 1871.

advantages under which a new branch of industry always suffers are overcome.

A High Standard of Purity of Water Essential.—But so slow and so naturally sceptical, in respect of new appliances, is the agricultural mind, that we must not wait for the recognition of the cultivator as the only thing necessary for the development of the value of sewage. We must rather trust to the obligation which will before long be imposed on all sewer authorities, so to treat the liquid refuse of towns that the effluent liquid shall conform to a recognised standard of purity; for it will only be by the most stringent enforcement of the law in this respect that all the manurial properties of sewage will be rendered available for reproduction.

Taking this view, I think it is much to be regretted that the Conservators of the Thames have, without pledging themselves to any positive decision, recognised a standard of purity* in some degree inferior to that suggested by the present Rivers Pollution Commissioners in their first report, and that they have done so in the face of a statement by the Commissioners, that they made the suggestion with the "belief that, as science progresses, improved methods of purifying polluted liquids will be discovered, and that eventually standards of purity considerably higher than those recorded may, if necessary, be enforced." Without presuming to give any opinion upon the details of the standard suggested by the Commissioners, which I know is regarded by some chemists as objectionable, I am content to record the fact that their anticipation has already been in a measure realised. This is not mere assertion; it has been conclusively shown that when natural soil is so prepared, by properly designed deep drainage and deep surface cultivation, that the whole of the sewage distributed upon its surface is absorbed and percolates *evenly* through the soil, the effluent liquid passes into the arterial outfalls from the under-drains purified to a very high degree, and unobjectionable in every respect. Such, in point of fact, appears to be the purification effected by oxidation, resulting from the aëration of drinage and the intermittent use of soil for filtration, that it is not at all a too sanguine view to take, that, with increased experience, we may arrive at a power of restoring water with which sewage has been mixed to its original potable condition.

For the convenience of those interested in the matter, I here give the standard suggested by the Rivers Pollution Commissioners, and will add that which has been circulated by the Thames Conservators. The Commissioners suggest that the following liquids be deemed polluting, and inadmissible into any stream:—

(*a*). Any liquid containing in suspension more than three parts by weight of dry mineral matter, or one part by weight of dry mineral matter in 100,000 parts by weight of the liquid.

(*b*). Any liquid containing in solution more than 2 parts by weight of organic carbon, or 0·3 part by weight of organic nitrogen in 100,000 parts by weight.

(*c*). Any liquid which shall exhibit by daylight a distinct colour when a stratum of it 1 inch deep is placed in a white porcelain or earthenware vessel.

(*d*). Any liquid which contains in solution, in 100,000 parts by weight, more than two parts by weight of any metal except calcium, magnesium, potassium, and sodium.

(*e*). Any liquid which, in 100,000 parts by weight, contains, whether in solution or suspension, in chemical combination or otherwise, more than 0·05 part by weight of metallic arsenic.

(*f*). Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than 1 part by weight of free chlorine.

(*g*). Any liquid which contains, in 100,000 parts by weight, more than 1 part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

(*h*). Any liquid possessing an acidity greater than that which is produced by adding two parts by weight of real muriatic acid to 1000 parts by weight of distilled water.

(*i*). Any liquid possessing an alkalinity greater than that produced by adding 1 part by weight of dry caustic soda to 1000 parts by weight of distilled water.

The following standard of purity for defecated water is that recommended by the chemists consulted by the Thames Conservators, and it will be seen that it is, as I have stated, less stringent than that suggested by the Rivers Pollution Commissioners. They say:—(1). It should be free from an offensive odour. (2). It should be free from suspended matters, or, in other words, be perfectly clear. (3). It should not be alkaline to turmeric paper, nor acid to litmus paper. (4). It should not contain per gallon more than 60 grs. of solid matter dried at 260° F. (5). It should not contain more than three-quarters of a grain of organic and ammoniacal nitrogen per gallon. (6). It should not contain more than 2 grs. of organic carbon per gallon. (7). It should contain not less than 1 cubic inch of free oxygen in a gallon." It should be observed, however, that one of the eminent chemists who signed this recommended standard, Dr. Frankland, being himself a member of the Rivers Pollution Commission, added these words:—"The conditions under which fluid which has been contaminated with sewage may be admitted into the Thames, as prescribed in the foregoing report, will, I have every reason to believe, preserve the river from being offensive to the inhabitants upon its banks; but, whilst thus far agreeing with my colleagues, I wish it to be distinctly understood that, in my opinion, such fluid can only be safely admissible into the Thames on condition that the water is not afterwards used for domestic purposes."

The conservators of the River Lea, in the absence of any standard recognised by the Government, have hitherto abstained from issuing one of their own, and the consumers of water in the metropolis are to be congratulated that they have done so, for the publication, limited though it has been, of the lower standard recommended to the Thames Conservators has already had the effect of encouraging results inferior to those which are to be desired. The Lea Board reserves to itself judgment until the towns discharging into the river have completed their purifying works, for which they have extended the time, at the expiration of which it is to be hoped that some positive action towards the establishment of standards to fit different circumstances will have been taken by the Central Local Government authority. Until such is the case, we shall probably see, both on the Thames and on the Lea, the sewer authorities of towns disregarding, naturally enough, the higher standard of the Rivers Pollution Commissioners, and in spite of the protest of Dr. Frankland, and the general sense of the country, the inhabitants of London may be compelled to drink polluted water, and as a natural consequence, the contamination of our streams will continue throughout the length and breadth of the land.

* The following notes to and from Captain Burstal, the Secretary of the "Thames Conservancy, will explain the position of this particular question at the present moment:—

"Stevenage, 24th November, 1871.

"Dear Sir,—I presume I am right in assuming that the standard of purification recommended by Drs. Frankland and Letheby, and Professor Odling is that which your Board of Conservators recognise as sufficient to regulate the influx of liquid sewage from towns on the banks of the Thames. When answering this question, would you kindly tell me whether the standard applies equally to the towns above Hampton as below.—"I am, dear Sir, yours faithfully,

(Signed) "J. Bailey Denton.

"Captain Burstal, Thames Conservancy."

"Thames Conservancy Offices, 41, Trinity Square, Tower Hill, E.C., 1st December, 1871.

"Dear Sir,—In reply to your letter of the 24th ult., I beg to inform you that the Conservators do not recognise any standard of purity for effluent water from sewage from places on the banks of the river above Teddington.—I am, dear Sir, yours faithfully,

"E. Burstal, Secretary.

"J. Bailey Denton, Esq., Orchard Court, Stevenage, Herts."

This point, however, is not that upon which I desire to dwell. It is of sewage as a fertiliser of land that I must speak, though it is right to repeat emphatically, what must be manifest to every practical mind, that so long as the pollution of rivers is permitted in a modified degree, by the recognition of any standard of inferior character, the fertilising ingredients of sewage will not be wholly recovered from the water with which they are mixed.

Sewage as a Fertiliser of Land.

To show what is the intrinsic value of the fertilising ingredients of sewage I will, in the shortest manner possible, state the conclusion to which Messrs. Lawes and Gilbert came in 1865, in their very complete and careful paper on the "*Composition, Value, and Utilisation of Town Sewage*" read before the Chemical Society, and which, I believe, expresses pretty accurately views in which the majority of those who are competent to deal with the subject concur. Having adopted the case of Rugby as a fair sample of water-closet towns, the discharged sewage being equal to 36 gallons per diem, or 60 tons per head per annum, including surface and subsoil waters, they stated that, "looking to the average results of 93 analyses," they found "that the sewage contained about 87½ grs. per gallon of total solid matter, of which about two-thirds was inorganic, and one-third organic. About half the total solid matter was in suspension, and half in solution; of the half in suspension, about four-sevenths was inorganic, and three-sevenths organic, and of the half in solution about four-fifths was inorganic, and one-fifth organic. Lastly, of the nitrogen, reckoned as ammonia, about one-fourth was in suspension and three-fourths in solution. The mean of the ninety-three analyses showed about 6½ grs. of ammonia per gallon, indicating a value of 1¾d. for the total constituents in 1 ton of sewage." These figures, multiplied by the 60 tons of sewage per head per annum, resulted in showing "that 12½ lbs. of ammonia were contributed annually for each average individual of the mixed population of both sexes and all ages." This quantity of ammonia, at 8d. per lb., gives 8s. 4d., or 100 pence, as the value of sewage per head from water-closet towns. Various other estimates have been made of the sewage of water-closet towns. Dr. Letheby took samples at noon and at midnight, from a number of sewers in the metropolis, and arrived at the conclusion that 7·24 grs. represented the mean quantity of ammonia per gallon. Messrs. Hofmann and Witt, having treated one particular sewer, considered that 8·21 grs. represented the quantity of ammonia. These two quantities would, if taken at the same price of ammonia, result in larger figures than those of Messrs. Lawes and Gilbert.

There have been several estimates made of the value of sewage, by modes of computation differing from that based on the whole sewage of towns as discharged by the sewers, and as they will assist us in considering what proportion of the excrementitious matter of the closet may be kept out of the sewers, with benefit to agriculture and profit to the ratepayers of sewered districts, I will shortly refer to them. Messrs. Hofmann and Witt, and Dr. Thudichum, having ascertained the amount of urine and fæces voided by individual persons, taking an average of both sexes of all ages, valued the urine at 7s. 3d. and the fæcal matter at 1s. 2¾d., which together, it will be observed, is very nearly the same amount as that put upon the whole sewage by Messrs. Lawes and Gilbert.

There is an anomaly in these estimates which has to be reconciled, inasmuch as it appears that the excrements of human beings alone, exclusive of the refuse from slaughter-houses, stables, cow-houses, and dog kennels, as well as that discharged from the kitchen, with its refuse of vegetable and animal food, is more valuable than the whole liquid refuse of a town, when the contents of the closet are discharged into the sewers as well as all other refuse. And the anomaly becomes more difficult of reconciliation when we have to consider a statement by the Rivers Pollution Commissioners to the effect that, comparing water-closet towns, in which the whole of the sewage issues from the sewers, with "midden" towns, in which a considerable portion of the human excreta is detained and disposed of separately, there is a remarkable similarity of composition between the two.

I will not detain you by any endeavour to reconcile these analyses and statements, but will only remark that, assuming them to be correct, an important consequence follows, viz., that, in an agricultural view, it is desirable to treat the excremental contents of privies separately, for if no appreciable loss of fertilising matter is found to exist in liquid sewage when separated from that of the privies, it is manifest that a decided national gain is obtained by the maintenance of the two systems, inasmuch as the dry, portable manure obtained from the privy contents will be so much fertilising matter available for distant lands, in addition to the liquid sewage, which may be utilised by irrigation near at home.

But the realisation of the fertilising value of sewage in the liquid state depends necessarily upon two precedent conditions, the first being the obligation which should be imposed on all towns by the central local government authority, to *perfectly* cleanse their sewage; and the next, the preparation by the sewer authorities of the land designed to receive the sewage, in such a way that the whole may be *fully* utilised. With these two duties performed, and not otherwise, there is a fair prospect of at least a penny a ton being realised for liquid sewage of average strength, half of which (as I have stated on former occasions) should go into the pockets of the ratepayers, in repayment for the necessary works, while the other half will be due to the cultivator as a return for his industry and the employment of his capital.

Excluding from consideration the value of the water, which, I contend, will become a great item in the profitable treatment of sewage, the subject before us may be classified under three heads, viz.—(1) Where the whole of the sewage is treated by chemical process at the mouth of the sewer. (2) Where it is transported from the sewer mouth to land for distribution there. And (3) Where a part of the excrementitious refuse is treated separately from the remainder. The question which addresses itself, therefore, to the authorities of all sewered districts is, which of these methods of treatment will best enable them to effect the twofold object of purifying the sewage and utilising it to the greatest advantage; while the question which the agriculturist has to consider is, which method will place at his command, at a fair price and in the most productive shape, the fertilising matter which the sewer authorities must extract in order to cleanse the sewage perfectly.

(To be continued).

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 21st, 1871.

Dr. WILLIAMSON, F.R.S., Vice-President, in the Chair.

AFTER the minutes of the previous meeting had been read and confirmed, Mr. William Gray and Mr. Reginald C. Woodcock were formally admitted as Fellows of the Society.

The names of the following gentlemen were read for the first time;—Benjamin P. Medcalf, William H. Chandler, Charles F. Chandler, Ph.D., and John Watts, D.Sc.

For the third time—William W. Abney, Jonathan Ingle Calvert, Christopher Childs, B.A., and Frederick J. Montague Page, who were balloted for and duly elected.

The CHAIRMAN having announced that the distinguished Italian chemist, Professor Canizzaro, had consented to deliver the Faraday Lecture, called upon Mr. Henry Bassett to read his paper on "*Eulyte and Dyslyte*."

Mr. BASSETT first gave the method employed to obtain these two substances which had already been briefly described in 1851 by Baup. Citraconic acid prepared by the dry distillation of citric acid, when treated in small portions at a time with strong nitric acid, yielded an oil which solidified to a crystalline mass on standing. This product consisted of a mixture of the crystalline compounds eulyte and dyslyte, contaminated, however, with a small quantity of a yellow oil. The *eulyte*, which can only be separated with difficulty, is more soluble in alcohol than the dyslyte. It crystallises from warm chloroform in large prisms, melting at 99·5° (cor.), the results of its analyses corresponding to the formula $C_6H_6N_4O_7$. Submitted to the action of tin and hydrochloric acid it gave large quantities of ammonium chloride, together with a small quantity of a tarry matter, soluble in potash, with the evolution of an odour of picoline. In one experiment the author obtained indications of a solid basic substance, but the material at his disposal was too small to enable him to determine its nature. *Dyslyte*, $C_8H_6N_4O_6$, is less soluble in alcohol than eulyte, crystallising therefrom in fine long needles, which melt at 189° (cor.). The yellow oil, separated from the mother-liquors and purified by distillation in a current of steam, had the characteristic odour of volatile nitro-compounds, and exploded when heated. It is the author's intention to further investigate the nature of these compounds as soon as he has sufficient material at his disposal for that purpose.

In reply to a question put by the Chairman as to what were the properties of the compounds he had described, whether acid or basic, Mr. Bassett said that he agreed with Baup, who described them as neutral substances, for, as far as he had been able to ascertain, they were not possessed either of acid or basic properties.

Dr. DEBUS having enquired as to the comparative amount of these substances obtained from citric acid, and also what was the precise action of reducing agents on them, Mr. Bassett stated that he had distilled 30 lbs. of citric acid, and had only obtained about 50 grms. of the substances; but from the experience he had gained in the method of preparing it he hoped to be able in future operations to obtain a larger yield. In acting upon them by reducing agents almost the whole of the nitrogen was eliminated as ammonia when the reduction was complete, only a small proportion of the nitrogen being found in the tarry product; the solid basic compound he had mentioned being formed before the reduction was entirely finished.

Dr. H. E. ARMSTRONG then read the following paper:—"*The Nitration Products of the Dichlorophenol-sulphonic Acids*," No. IV.

The author first remarked that the action of nitric acid on the sulpho-acids prepared by treating dichlorophenol melting at 103°, which would indicate that this sulpho-acid was only isomeric with those obtained by the chlorination of the meta- and para-phenol-sulphonic acids, as these yielded chloronitrophenols melting at 121·5° and 125°, corresponding respectively to dinitrochlorophenols melting at 80·5° and 111°. When, however, the potassium salt of the sulpho-acid obtained by acting on dichlorophenol with chlorhydric sulphate, SO_2OHCl, was treated with nitric acid, the sole product obtained was invariably the nitrodichlorophenol melting at 121·5°, even under varying conditions of temperature and strength of acid. From former observations which the author has made he believes that the acid formed by the action of SO_2OHCl is dichlorophenol *meta* sulphonic acid, and hopes to be able to obtain the phenol-metasulphonic acid from it by the action of nascent hydrogen. The difference in the results obtained by the nitration of the two acids prepared from dichlorophenol by the action of sulphuric acid and chlorhydric sulphate respectively, would indicate that they were *isomeric* and not identical; this view, moreover, is borne out by an examination of other sulpho-products of the benzol series obtained by the use of these two reagents. This, the author thinks, might have been theoretically predicted if the conditions are considered under which the various substituted phenols are formed; the "reactive energy" of sulphuric acid being feeble compared with that of chlorine, for by its action on phenol it produces *meta*- and *para*-sulphonic acids, whilst chlorine in the cold gives rise to two chlorophenols; but by far the larger proportion of the mixture consists of *ortho*-chlorophenol. The "reactive energy" of the chlorhydric sulphate is far greater than that of sulphuric acid, being comparable in its action to chlorine rather than to sulphuric acid, and should, therefore, give rise to derivatives belonging to a different series. In all probability, however, there is a direct relation between the amount of heat evolved during the formation of a substitution derivative and the place it occupies in the isomeric series. The consideration, therefore, of the heat evolved in the formation of isomeric bodies would doubtless throw great light on the subject.

Dinitrochlorophenol melting at 130°.—This body, which was obtained by Stenhouse, by the action of chloride of iodine on picric acid, in the author's opinion is not identical with that prepared by Griess by nitrating crude chlorophenol, the latter being the β dinitrochlorophenol melting at 110° to 111°, especially as the amido-derivatives obtained from the two compounds differ considerably in appearance and properties. This discrepancy appears to have arisen from Griess's compound being contaminated with traces of the isomeride, melting at 80·5°. The author has also obtained trichlorophenol-sulphonic acid by acting on trichlorophenol with chlorhydric sulphate.

Professor WILLIAMSON remarked that these compounds were very interesting, particularly to those who had made the subject their especial study, and he should be very glad if Dr. Armstrong would give the members his opinion as to the difference between the action of hydric sulphate and chlorhydric sulphate, as he understood him to say that they only differed in degree.

Dr. ARMSTRONG replied that the question was one of so complex a character that he could not at present venture to give any opinion on the subject, but he believed that there was a direct relation between the amount of heat evolved during the reaction and the position which the resulting compound occupied in the series; he had undertaken some experiments in this direction, and hoped that the results would throw some light on this matter.

Dr. MULLER, in connection with the difference observed in the action of sulphuric and chlorhydric sulphate, called attention to the action of chlorine on toluol under varying conditions, producing chlortoluol in the cold or in the presence of iodine, even when the latter is in comparatively small quantity, whilst at boiling heat it yields the isomeric benzylic chloride.

Dr. ARMSTRONG said that in the case of chlorhydric sulphate the action was not at all the same as that of sulphuric acid, being far more energetic and in that respect comparable to chlorine rather than to sulphuric acid. Again, iodine alone did not produce a substitution compound with benzol, but it did so when iodic acid was present; the action of the latter had been supposed to be due to its removing the hydriodic acid as soon as formed, but this would seem to be doubtful, as iodine in the presence of mercuric oxide produced iodine substitution compounds with benzol, and Lippmann had observed that amylene under similar circumstances gave compounds containing oxygen.

The meeting was then adjourned until Thursday, January 18, 1872.

GLASGOW PHILOSOPHICAL SOCIETY.

(CHEMICAL SECTION).

Ordinary Meeting, December 18th, 1871.

JOHN JEX LONG, Esq., Vice-President, in the Chair.

A PAPER was read by Mr. JOHN FERGUSON, M.A., Assistant Professor of Chemistry in the University of Glasgow, on "*Historical Notes on the Discoveries of Dr. Joseph Black.*" After briefly tracing the early life of Black, the author proceeded to notice his career as a student, first at the University of Glasgow and afterwards at the University of Edinburgh. In the former, Black was brought into intimate contact and personal friendship with Dr. Cullen, who was then the Professor of Chemistry in Glasgow, and it was under the tuition of that eminent philosopher that Black laid the foundation of his own future eminence as a chemist. Black afterwards went to Edinburgh, where he re-commenced and completed his medical studies, and while residing in that city his attention was specially taken up with the explanation of the facts connected with the difference of properties manifested by the caustic and so-called mild alkalies. It was this subject and his discovery of fixed air that he chose for his inaugural dissertation when he proceeded to take his medical degree. The author dwelt at considerable length on this dissertation, and treated it with marked critical ability. He showed how, step by step, Black arrived experimentally at the grand general conclusions which have now been universally accepted by the scientific world; and he gave him all due praise for the simplicity, perspicuity, and precision of his reasonings, while he at the same time regretted that Black, with such great abilities, had contributed so little to the sum total of the science of chemistry. Mr. Ferguson also referred to Black's discovery of the principle of latent heat, and to his career as a Professor in Glasgow and afterwards in Edinburgh, and in both cases in succession to his former master and friend, Dr. Cullen. A few remarks were also made in reference to the relationship in which Black and Lavoisier stood to each other as men of science.

A brief discussion followed, in the course of which Mr. SUTHERLAND took exception to the unfavourable estimate formed of Lavoisier by Mr. Ferguson, to which that gentleman replied that if it were thought that he had done Lavoisier any injustice, he would willingly go over the whole subject of his life again, and give the results of his inquiries to the section. He also stated, in reply to a question, that he was not sure that Priestley's discovery of oxygen was published in this country before the fact was communicated to Lavoisier.

A most cordial vote of thanks was awarded to Mr. Ferguson for his exceedingly interesting paper.

NOTICES OF BOOKS.

A Systematic Handbook of Volumetric Analysis; or the Quantitative Estimation of Chemical Substances by Measure, Applied to Liquids, Solids, and Gases. By FRANCIS SUTTON, F.C.S., Norwich. Second Edition. London: Churchill. 1871.

THE second edition of Mr. Sutton's well-known work on Volumetric Analysis, fully realises any expectations that may have been formed by chemists using the former edition of this handbook. Many changes have occurred in theoretical chemistry since the issue of the first edition seven years ago, and general advance has been made in chemical analysis, but there is nothing remarkable in the progress of volumetric analysis as a method, although its application has been greatly extended. The usefulness of the work has been much increased by the additions made by Dr. Frankland and Mr. W. Thorpe, F.C.S., to the subject of water analysis. The analysis of gases has been elaborated by Professor McLeod of the Indian Civil Engineering College, whose labours in relation to this subject are well known. The extensive illustration of this section of the work prevents the quotation, with fairness to Mr. Sutton, of any matter likely to interest our readers. The modern system of atomic weights has been adopted in this edition. There has been much done to render the work easily understood in the technical laboratory to which this method of analysis is peculiarly suited. It is too generally considered a standard work to require any further recommendation.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Under this heading will be found an encyclopædic list of chemical papers published abroad during the past week, with abstracts of all susceptible of advantageous abridgment. The two half-yearly volumes of the CHEMICAL NEWS, *with their copious indices, will, therefore, be equivalent to an English edition of the "Jahresberichte."*

NOTE. All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, December 4, 1871.

In addition to several important original papers and memoirs relating to astronomy, meteorology, geology, and natural history, this number contains the following original papers more particularly bearing upon chemistry:—

Separation of some Metals from each other, and Quantitative Estimation thereof by means of a Galvanic Current.—Dr. Lecoq de Boisbaudran.—After first referring to his former researches on this subject, the author states that it is by no means difficult to separate the more readily reducible metals when in acid solution from the less readily reducible metals present in the same solution, by the application of a moderately strong galvanic current; in this way the different metals may be classed in groups. As regards such metals as cobalt, nickel, and zinc, they are best precipitated from solutions containing excess of ammonia. Iron cannot be well estimated by this process because peroxide is formed.

Observation on Mr. Ritter's Paper on the Formation of Urea from Albuminoid Matter by the Action of Permanganate of Potassa.—A. Béchamp.—The contents of this paper simply bear upon the fact that the author, many years ago, discovered and published in various scientific periodicals some particulars which Ritter (see CHEMICAL NEWS, vol. xxiv., p. 288) states to be new.

New Method of Preparing the so-called Supersaturated Solutions.—L. C. de Coppet.—Anhydrous sulphate of soda, and likewise anhydrous carbonate of soda, and partly dehydrated sulphate of magnesia, are employed by the author to produce with cold water so concentrated solutions of the salts alluded to that, upon some small crystal of any of these salts being immersed into these solutions, they at once crystallise. It is, however, necessary for the success of the experiment that the salts be added to the water in small quantities at a time; by doing this carefully it is possible to dissolve in cold water five times as much anhydrous sulphate of soda, as water of the same temperature will keep in solution of the salt $Na_2SO_4,10H_2O$.

Comparison between Two Kinds of Arable Soil, One of which was Formerly Woodland, the Other a Partly Broken-Up and Limed Soil.—Th. Schlœsing.—The author records a series of experiments made with samples of surface soil and subsoil, taken from a locality in the Département de la Manche, chiefly with the view of ascertaining the effects, both physical and chemical, of the liming and non-liming of soils of a very poor nature. One of the effects of liming appears to be the conversion of chloride of sodium present in the soil into chloride of calcium, while nitrification also appears to be promoted by the lime. The greater part of the contents of this elaborate essay is of local interest only.

Testing and Quantitative Estimation of Arachis Oil in Olive Oil.—A. Renard.—The author bases this process upon the detection of arachidic acid. A quantity of 10 grms. of the oil to be tested is first saponified; the soap obtained having been decomposed by hydrochloric acid, the fatty acids set free are dissolved in 50 c.c. of alcohol at 95 per cent, the warm solution is precipitated by acetate of lead, and filtered after having become cold. The residue on the filter is treated with very strong and pure ether, which dissolves the oleate of lead, leaving margarate, palmitate, and arachidate of that metal. This compound

is heated, and then treated with warm dilute hydrochloric acid; the fatty acids are separated by decantation from the solution of chloride of lead. When the fatty acids are cooled, and thereby solidified, the cake thus obtained is dissolved in 50 c.c. of alcohol at 95 per cent by the aid of heat; a single drop of hydrochloric acid may have to be added to this solution in order to render it free from a slight cloudiness. If the olive oil operated upon happens to contain arachis oil, there will separate from the alcoholic solution, on cooling, crystals of arachidic acid. In order to estimate the quantity thereof, the crystalline mass is collected on a filter, first washed with a quantity of from 10 to 20 c.c. of the strong alcohol just alluded to, and next with ordinary alcohol, wherein this acid is insoluble. The substance upon the filter is next treated with boiling hot absolute alcohol, wherein the acid is dissolved, the filtrate collected in a previously weighed capsule, and the residue, left after a carefully conducted evaporation, weighed. The fusion-point of arachidic acid, obtained in this manner, is about 71°; of the pure substance, 73°. The author enters further into lengthy details as to the method of estimating the minute quantity of the arachidic acid dissolved (and therefore not collected along with the great bulk) in the strong alcohol used in these operations; the process is such that it may with due care yield very accurate results. Arachis oil is better known as ground-nut oil.

Composition of Lignites, and the Heat they Yield by Combustion.—Drs. Scheurer-Kestner and C. Meunier.—The authors communicate in this lengthy essay another portion of their very valuable and excellent researches on fossil fuel: this paper records the analysis of six different samples of lignite, three of these being obtained from different localities in France, and three from Bohemia. The analyses give—(1) The composition of the mineral as met with; (2) of the same, deducting ash and hygroscopic water; (3) the composition of the volatile portion of the mineral, less the water; next, the heat evolved by combustion as found by experiments is quoted; further, the calculated caloric; and, lastly, the sum of the caloric due to the combustion of the elements of which the lignites are composed. Lignite, the authors found, is distinguished from coal also in this particular—that the latter emits a far greater quantity of heat than that due to the combustion of its elements (carbon and hydrogen). Attention is again called to the fact that it is impossible to judge of the value of a fuel according to its elementary composition; all calculations based upon such data are quite fallacious, and the authors prove this conclusively by referring especially to one of the samples of lignite they investigated.

Analysis of Cows' Milk Taken from the Animals while Attacked by Typhus.—Dr. Husson.—The milk of twenty-two cows, belonging to the same proprietor (of which number four were so badly attacked by contagious typhus as to necessitate the immediate killing of the same, while another batch of four were apparently quite well, and fourteen in a doubtful condition), has been investigated by the author. It appears that, as compared with the composition of normal milk, the milk of all these animals became more or less altered as regards the quantity of normal constituents, and may be termed very poor; yet, with the exception of the milk taken from the four cows which were very ill, there was nothing disagreeable about these samples of milk, and of the milk, which had got a bad taste and colour, a cat drank some 50 grms. without experiencing any bad effects. The author draws this conclusion, among others, from his researches—that neither the milk nor meat from cows so diseased can give the disease to men or other animals not belonging to the *Ruminantia*; yet, very properly, the author urges that severe measures should be taken to prohibit the use of milk as well as meat of cattle even suspected to be attacked by contagious typhus to be used as food; in fact, the milk, even at the first beginning of the disease, is entirely altered chemically as well as in its histological characters, as revealed by the microscope. Samples of milk:—A. From the apparently healthy cows. B. From the least ill. C. From the worst ill. The Sample A appeared to be milk in its normal condition; the two other samples exhibited a yellowish rose-red hue, and the taste of Sample C was very disagreeable. In 1000 grms. the samples contained:—

	A.	B.	C.	Average Composition of Milk in its normal state.
Butter	16·96	14·93	12·60	30
Milk sugar ..	33·90	31·40	16·45	30
Casein	,,	50·25	,,	34
Albumen	,,	20·60	,,	6
Salts	,,	18·50	,,	7

New Researches on the so-called Widmannstätten Figures.—Dr. S. Meunier.—The author states that when a piece of meteoric iron is fixed to the positive pole of a Bunsen battery, the other pole being a piece of silver, and the electrodes are placed in an aqueous solution of bisulphate of potassa, and contact made, there will appear on the iron an iridescent colouration akin to the colouration brought about by heating the polished iron; if no contact takes place, there is produced upon the iron a figure similar to that which acids produce, but by this method it is more readily and more neatly brought out.

Revue Universelle des Mines, de la Métallurgie, des Travaux Publics des Sciences et des Arts Appliquées à l'Industrie, July and August, 1871.

In addition to important original papers on mining and on safety-valves of steam-boilers, this number contains the following original memoir relating to chemistry:—

Progress Made in the Chemical Works Situated in the Valley of the Sambre (Belgium) in the Condensation of Noxious Vapours.—Dr. J. T. P. Chandelon.—This exhaustive and very important essay is the published reproduction of a report made by the author to the Belgian Minister of Home Affairs, and may be considered akin to the reports annually made by the Inspector under the Alkali Act, and published in this country; but, in this instance, the sulphuric acid manufactories are included, and the arrangement of the memoir is retrospective—that is to say, the present condition of all the chemical works alluded to is compared with the condition prevailing a few years ago. It appears that a very general improvement has taken place in every respect, and notably, also, in the quantity of sulphuric acid obtained from a given quantity of sulphur burnt in the shape of pyrites. The condensation of hydrochloric acid resulting from the decomposition of common salt in the alkali-works is also very complete.

Revue Hebdomadaire de Chimie Scientifique et Industrielle, November 30, 1871.

Preparation of Pyrophosphate of Lime for Agricultural Purposes.—E. Deligny.—The coprolites, or other native tribasic phosphate, or bone-ash, is first treated with hydrochloric acid, and the mixture thus obtained dried in reverberatory furnace, leaving a pyrophosphate of lime, which, according to the author, contains 55 per cent of phosphoric acid, while the hydrochloric acid used is—at least in a great measure—recovered. The reaction is based upon the fact observed by the author, that from a mixture of acid phosphate of lime and chloride of calcium, when heated to 100°, the hydrochloric acid is driven off by the acid phosphate, leaving a bibasic phosphate, which is very readily assimilated by plants.

Use of Manure for Beet-roots.—M. Pagnoul.—It appears, from the contents of this paper, that soluble alkaline chlorides are not only not required for the healthy development of beet-roots, but that, these salts cause the roots to become less filled with saccharine juice. The quantity of alkaline carbonates left, after the incineration of the organic substance of the roots, as ash, and derived from organic salts present in the root, appears to decrease with an increase of the sugar; yet the author states that, whereas alkaline chlorides are not necessary to the life and development of beet-roots, alkaline carbonates ought, in small quantity, to be present, either in the soil wherein the roots grow or in the manure supplied to them, otherwise a healthy growth is not possible.

Continuation and End of the Lengthy Essay on the Chemical Dissociation of Bodies.—C. Mène.

Apparatus for the Combustion of Petroleum Oils to be used as Fuel.—H. Sainte Claire Deville and M. Wiesnegg.—This paper is illustrated by a woodcut. The furnace and accessory contrivances appear to be well suited for laboratory use when made on the small scale, and for manufacturing purposes when constructed in large size; the heat developed is very great, and there is no inconvenience of ash or smoke.

December 7, 1871.

On Fermentation in General.—C. Mène.—This paper is an excellent and very clearly written account of fermentation as understood by the ancients, the alchymists, the iatro-chemists. The microscopical researches made on ferment in 1680 by Antony van Leeuwenhoeck are also briefly stated.

Process of Purification of the Crude Suet of Commerce.—J. Costhelys.—The author describes at length a process of purifying such fat-tallow as has been rendered, as it is termed, by the aid of sulphuric acid. The new process here described aims at the refining of the tallow, so that it may be used as dripping. From what is stated it appears that the result is, as was practically tested in Paris during the late siege, highly satisfactory.

New Rheometric Regulator for Gas-Burners.—M. Girond.—The contents of this valuable paper, illustrated by woodcuts, make us acquainted with a very ingeniously contrived regulator for gas-burners, whereby the consumers of gas who apply it to their burners have a perfect control over the quantity of gas consumed by each burner in a given time. As regards the further details on this subject, it would require the reproduction of the woodcuts. We hope the author will introduce this useful instrument in this country.

New Use for Silicate of Soda.—C. Mène.—The substance alluded to, in rather concentrated state, is first mixed with zinc-white (oxide of zinc of commerce), and may then be, as is actually the case in France, used as an excellent and resisting paint for out-door work on wood, metal, stone, paper, roofing felt, &c. Combustible substances coated with this material are, moreover, rendered uninflammable.

Les Mondes, December 14, 1871.

Extraordinary Cold Weather.—Rev. F. Moigno.—On Saturday, December 9th, the reading of the thermometer at the National Observatory at Paris was, in the morning (8 o'clock), −21·92° = about −7° F. Never since January 23rd, 1788, has the temperature been so low in Paris; at the Montsouris Observatory, situated beyond Paris proper, in the suburbs, the reading on the same day and hour was −23·7°. The late Arago states, in his work on Astronomy, that the lowest temperature observed in Paris since 1665 was −23·5°, on January 25th, 1795.

Newly-invented Apparatus for Evaporating Liquids.—A. Wérotte.—An ingenious contrivance, illustrated by a woodcut. The apparatus is designed for evaporation on the large scale.

Although not exactly belonging to the subjects usually treated in our columns, we quote the title of the following work, which is highly spoken of in the above-named periodical:—"Dictionnaire Général des Forêts, Legislation et Administration, recueil complet comprenant le résumé el l'analyse des lois, règlements, ordonnances, arrêts, decisions, &c., concernant les forêts depuis 1672 jusqu'au 1 Janvier, 1871," par A. Rousset, Sous-Inspecteur des Forêts. 2 vols., avec planches et modèles publié chez l'auteur à Nice, rue Cassini, 15. 1871.

December 21, 1871.

Observatory on the Puy de Dôme.—Rev. F. Moigno.—The locality alluded to is a rather elevated mountain situated in the Département of the same name, and not very far distant from the city of Clermont-Ferrand. It appears that, just previous to the breaking out of the late war Dr. Alluard, Professor of Natural Philosophy at the city above named, had proposed to the French Government to establish an observatory on the top of the mountain just named; to establish in the city a laboratory, to which a special room for meteorological observations should be attached; and to construct a line of telegraph wires, to communicate, on the one hand with the two establishments, and on the other, by a separate wire, with the Observatory at Paris. The present French Government and the local departmental and municipal governments, having had this plan surveyed, have agreed to execute the necessary works at once.

Some Observations und Objections on the Supersaturation of Liquids by their own Vapour.—Rev. Father Sanna Solaro, S.J.—This very lengthy essay bears upon a portion of Mr. Tomlinson's paper which was reproduced in the above-named periodical. We reserve this paper for full translation.

Preservation and Improvement of Beet-Root Leaves to be Used as Fodder for Cattle.—Dr. Méhay.—The process here described essentially consists in steeping for a few minutes the leaves and heads of the beet-roots in weak hydrochloric acid (4° Baumé = 1·027 sp. gr.), leaving the vegetable matter to drain for a moment, after which it is placed in heaps into a kind of tank-like hole dug into the soil, care being taken to line its bottom and sides with straw. When filled the heap is first lightly covered with straw and then with earth—in fact, arranged in the manner used for preserving potatoes, carrots, &c. From the testimony of competent agriculturists and veterinary surgeons, the process here alluded to is indeed to be recommended for its good effect upon the cattle fed by vegetable matter thus preserved.

La Revue des Scientifique de la France et de l'Etranger, December 16, 1871.

This number does not contain any original papers relating to chemistry.

Journal für Praktische Chemie, No. 18, 1871.

This number contains the following original memoirs and papers:—

On the Compounds of Tin and Titanium Crystallising from Glassy Fluxes, namely, Fused Beads obtained by the Blowpipe Flame.—G. Wunter.—The contents of this paper record a series of chemico-crystallographical experiments made by the author with a view to ascertain whether it is possible to obtain definite crystalline compounds and titanic acid by fusing together oxide of tin with borax and phosphor salt; the method of analysing these substances is also fully described. Among the tin compounds we quote the formulæ of the following:—

$$\underbrace{Sn_2Na(PO_4)_3}_{\text{Rhombohedra.}} + Na_2PO_4 = 2\underbrace{[SnNa_2(PO_4)_2]}_{\text{Tetragonal pyramids.}};$$

$SnNa_2(PO_4)_2$ pyramids in 100 parts:—SnO_2, 42·37; P_2O_5, 40·11; Na_2O, 17·51. Rhombohedra, $Sn_2Na(PO_4)_3$, in 100 parts:—SnO_2, 54·82; P_2O_5, 39·44; Na_2O, 5·74. Titanium compound, $TiO_2Na(PO_4)_2$:—TiO_2 40·80; P_2O_5, 52·20; Na_2O, 7·60.

Relation Existing between the Specific Gravity of, and the Quantity of Pigment contained in, Indigo.—G. Leuchs.—The author relates a series of experiments quoted in tabulated form, exhibiting the sp. gr. of various samples of indigo and the quantity of indigotine therein contained, the latter particular being estimated by a process described in one of the earlier published volumes of this periodical; it appears that in forty-nine different samples of dye-stuff alluded to, the best contained 60·5 per cent of indigotine and the worst 24 per cent, the sp. gr. of the former being low and the latter high.

Mineralogical Miscellany.—A. Frenzel.—This paper contains the following sections:—Lithiophorite; hypochlorite; pucherite.

Preparation of Carboxycyanide.—Dr. W. F. Gintl.—At present this paper contains only an incomplete account of the author's researches on this subject now made public in consequence of an account of similar researches having been lately published by other German *savants*. A complete account of this investigation will be given.

On Hygienico-Chemical Methods of Investigation.—Dr. H. Fleck.—First instalment. Detection and estimation of organic matter in water. Reserved for full translation; an observation also applicable to the following paper:—

Determination of Ammonia in River and Well Waters by Means of Nessler's Test.—E. Schürmann.

Electrolysis of Itaconic Acid.—G. Aarland and E. Carstanjen.—After first referring to Kekulé's, Kolbe's, and Liebermann's experiments on the electrolysis of some organic acids, the authors describe the method of experimenting with itaconic acid, which is decomposed by the electric current, yielding carbonic acid and allylen, C_3H_4.

Monochloracetate and Amidoacetate of Phenol.—E. W. Prevost.—Monochloracetate of phenol smells like phenol, exhibits an acid reaction, is insoluble in water, readily soluble in alcohol and ether, fuses at 40·2; formula, $C_6H_5.O.(C_2H_2ClO)$; when this compound is heated up to 140° along with ammoniacal alcohol in a sealed tube, there is formed amido-acetate of phenol, $C_6H_5.O.(C_2H_3H_2N,O)$, a crystalline white-coloured body, acid reaction, soluble in water, almost insoluble in alcohol and ether; may be heated to 133° without undergoing any other change than becoming soft; at a higher temperature it is decomposed.

Probable Existence of Two Oxysulphides of Carbon.—Dr. H. Kolbe.—The contents of this paper are devoted to a theoretical discussion of what may be, though not yet experimentally proved to be, the result of the decomposition of sulphocyanide of potassium and isosulphohydrocyanic acid under the influence of sulphuric acid. The author illustrates this subject by a series of formulæ, and intimates that one of his assistants has commenced experimental researches on this subject.

NOTES AND QUERIES.

Residue from Olive Oil Presses.—Can your readers inform me if it is possible, and where, and how, I can obtain some of the residue from olive oil presses; I mean the fruit which remains after the oil is pressed out.—OLEUM.

Dehydrating Oxalic Acid.—(Reply to "Q. R.")—Crystallised oxalic acid = $HO,C_2O_3,2aq$. The dehydrated HO,C_2O_3 can be obtained by drying the crystallised acid at 100°, or at utmost 120°. Oxalic ether cannot be made in the way proposed by you, but is made by distilling a mixture of an oxalate along with strong alcohol and strong sulphuric acid. Dr. Miller's excellent work on Chemistry will give you full particulars.

Adulterations in Food and Drink.—(Reply to "An Amateur Chemist.")—You will find the work published under the following title a valuable and reliable aid:—"Die wichtigsten Lebensbedürfnisse, ihre Aechtheit und Güte, ihre Zufälligen Verunreinigungen und ihre Absichtlichen Verfälschungen mit gleichzeitiger Berucksichtigung der in Haushaltung, den Künsten und Gewerben Bernutzten Chemische Gifte (Polizeilich-Gerichtliche Chemie)," von Dr. Adolf Duflos (Breslau: F. Hirt.

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